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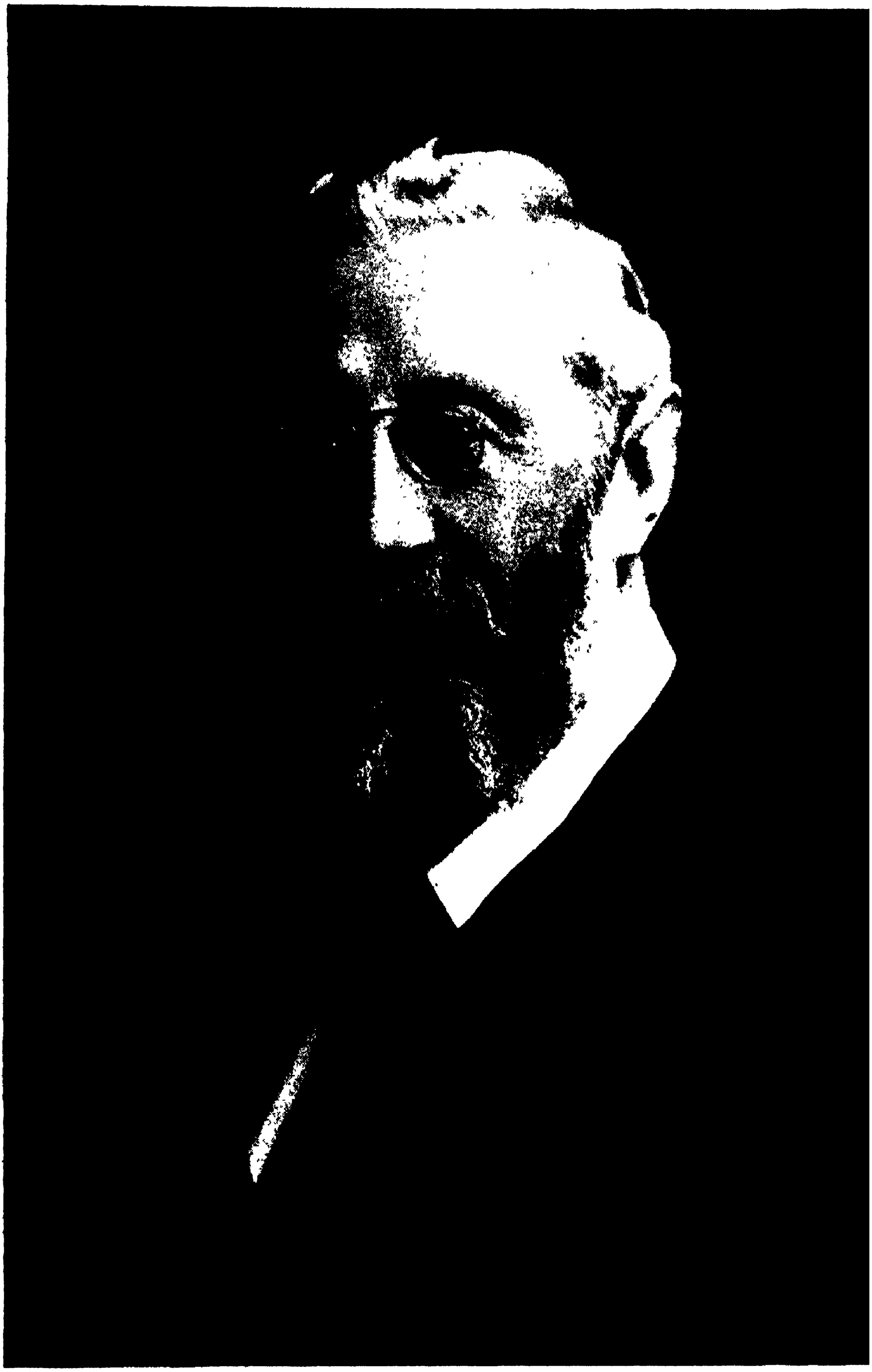


Photograph by Elliott and

The Late Mr. J. W. McConnel

The first Chairman of the Council of the Empire Cotton Growing Corporation

THE
EMPIRE COTTON GROWING
REVIEW

VOL. I. JANUARY, 1924. NO. 1.

THE EMPIRE COTTON GROWING CORPORATION

In this, the first number of the quarterly journal of the Empire Cotton Growing Corporation, it will be convenient to trace the history of that Corporation up to date, and to explain the scope and purposes of the journal issued under its auspices.

The importance of the cotton trade, not only to Lancashire but to the British Empire, is indisputable. In 1917 Mr. J. Arthur Hutton, Chairman of the Council of the British Cotton Growing Association, stated that it was estimated that no less than ten millions of the population of this country were directly or indirectly dependent on the cotton trade for their daily bread. In 1913 our exports of cotton goods alone amounted to £127,200,000 out of a total of £411,400,000 of exports of manufactured goods. Our imports of raw cotton in that year were £70,690,000, of which £9,200,000 worth was re-exported. These figures are by no means exhaustive, and if the figures of manufacture for consumption at home, of insurance, financing, freight, and merchants' commissions and profits are examined, it would be seen that, large as are the above sums, they by no means represented the total value of the trade. Mr. Hutton calculated that the approximate capital engaged in or directly dependent on the trade in that year was:

	£
Spinning and weaving mills	150,000,000
Bleaching, dyeing, printing, and finishing works	60,000,000
Engineering, machinery, ironworks, collieries, etc.	60,000,000
Railways, canals, shipowners, etc.	120,000,000
Merchants, brokers, distributors, solicitors, banks, insurance companies	120,000,000
Total ..	£510,000,000

Even at the present time, when the difficulties of the Lancashire cotton trade are probably more severe than they have ever been in its history, the importance and value of that trade to this country has increased rather than diminished, and its depression reflects accurately what exists in every trade throughout the country. Cotton growing in the Empire is still in its infancy, but even so, what has been achieved in some of the Colonies has made the difference between poverty, or dependence on a grant in aid, and comparative prosperity. It is impossible at this stage to predict the full meaning of cotton growing on a large scale to the natives of these Dependencies. The transfer of their attention from pastoral pursuits and the ownership of cattle to agriculture marks, in some parts of Africa at least, probably the healthiest development from barbarism to civilization, while the actual monetary reward of cotton growing will inevitably tend to a demand for various advantages of civilization which, in turn, will react on the industries of this country.

Not only is the cotton trade immensely important, but it is both well organized and progressive. In 1902 the British Cotton Growing Association was formed at the instance of the Manchester and other Lancashire Chambers of Commerce and leading West African merchants of Liverpool, with a view to developing the growth of cotton within the Empire. In a brief article of this description it is not possible to tell the story of the Association, or to indicate more than vaguely the debt owed to it for its immense and patriotic exertions, which have led to the production in 1921 of over 165,000 bales of cotton from territories from which little or none was exported before 1902. Suffice it to say that the Council of the Association were among the first to recognize that something more was required than could be done by the Association alone if cotton growing within the Empire were to be made completely successful. It was felt that, if rapid progress were to be made, some kind of a public body must be engaged in fostering the growing of cotton, and that private enterprise must be assisted. Among the pioneers of this movement, which led, first to the appointment of the Empire Cotton Growing Committee, and finally to the creation of the Empire Cotton Growing Corporation, it was considered that, whatever the organization of such a body, it would not be possible for unassisted private enterprise to undertake any such duty unless it were freed from commercial considerations and anxieties. Scientific and experimental work, in the shape of research and practical experiment, carried out in various places within the Empire, and tabulated at some central bureau, would be necessary, while other duties would include the creation of a staff of agricultural advisers, who were also cotton experts and could work with existing agricultural departments, the compilation of statistics helpful to growers and spinners, the study of the economics of cottons, and advice on schemes of development directly and indirectly connected with cotton. Many of these functions had been undertaken by the British Cotton Growing Association, but others, it was recognized, were possible only for an organization directly supported by and acting in co-operation with Government. Scientific work, for instance, could be developed to its fullest extent only if it were carried out at the centre of Empire and under the auspices of the Imperial Government, while an efficient staff could not be created save by a body in close touch with the Governments of India and the Dominions and Colonies concerned, and by some system of interchange, for it was evident that these Governments could not agree to putting their cotton growing entirely under the control of an Imperial Cotton Growing Board and ignoring their own agricultural advisers. On the other hand, it would not be satisfactory to control cotton growing from the Colonial Office, which could not hope to keep touch or co-operate efficiently with either the industry in India and Egypt or the spinning and manufacturing interests in this country.

In December, 1916, the Council of the British Cotton Growing Association held a conference with representatives of the cotton trade, and resolutions including the following were passed:

> (*a*) That it is essential for the future prosperity of this country and also for the welfare of the Colonies that cotton growing should be developed as rapidly as possible in all suitable parts of the Empire.
>
> (*b*) That a committee be appointed to consider the best method of continuing and developing the work inaugurated by the British Cotton Growing Association. . . .

In the following February the President of the Board of Trade received a deputation representing both employers and operatives of the cotton trade, and was urged to appoint a Committee which should consider the whole subject of the best way of organizing the cotton growing of the British Empire. A few months later a large Committee, representing both Government Departments and the cotton trade, was appointed under the chairmanship of Sir Henry Birchenough.

The report of this Committee, which was presented towards the end of 1919, is a document of the very highest value, containing as it does the sifted information of an immense number of witnesses with either expert knowledge of cotton in all its stages of growth and manufacture, or varied and detailed knowledge of Imperial and

Colonial administration. In this report will be found not only detailed notes on the subject of cotton growing within the Empire, but also on the prospective needs of the industry and the serious nature of the dangers which threaten it.

As a result the Empire Cotton Growing Corporation has been formed under Royal Charter, and is representative of all the interests concerned in the cotton trade, while the great Departments of State are also adequately represented. The permanent staff of the Corporation are housed in offices in Millbank House, Westminster, which is situated conveniently close to the chief Government offices. The Earl of Derby is the President of the Administrative Council, and Mr. J. W. McConnel was the first Chairman of the Council and Executive Committee. On his lamented death Mr. R. H. Jackson succeeded him.

Without entering into administrative details, the Corporation may be described as analogous to an information and spending department without Treasury control, but under the direction of its own Finance Committee. It is in possession of an assured income, derived in part from a capital contribution of nearly one million pounds made by the Government, and in part from the proceeds of a levy of sixpence per standard bale on all cotton purchased by spinners in this country. This levy, in accordance with the wishes of the great majority of the trade, has been made obligatory on all spinners and is enforceable by law, in terms of an Act of Parliament which received the Royal Assent in July, 1923.

Until the passing of this Act it was not possible for the Corporation to initiate any far-reaching and extensive schemes of development. A certain amount of work has been done and special reports have been made on the subject of the development of cotton growing in Nigeria, Tanganyika, Nyasaland, Western Australia, and South Africa. Expert assistance has been lent to the Governments of Tanganyika, Nyasaland, and Queensland. Students have been trained in increasing numbers, and assistance of a practical nature has also been given to the Sudan Government, which is engaged on the development of an irrigation scheme. This project, it is believed, will make it possible to grow cotton on a very large area hitherto of no value for agricultural purposes owing to absence of water.

The value of the work initiated can only be judged after some years have elapsed, for it must be remembered that growing and marketing cotton are not only in themselves complicated and difficult operations, but, in order that they shall be economically successful within the Empire, they must be organized efficiently, and so compare favourably with the great and highly organized industry of growing and marketing in the U.S.A. Not all varieties will suit all climates and soils, and careful and protracted experiment is usually necessary before the growth of cotton on a commercial scale can be undertaken in any new area. It is hoped and believed that the results obtained will be worthy of the self-sacrificing enthusiasm and foresight of the trade and the unequalled knowledge of the many experts who have given their services so generously to the Corporation and enabled it to build on a sure foundation.

As has been already mentioned, it was considered necessary by the Empire Cotton Growing Committee that the Corporation should become the Central Bureau of Information to collect and disseminate knowledge of all matters of interest to scientific and other cotton growers, and should publish a journal to this end.

It is complained sometimes that neither spinners nor growers know much about each other's requirements and the difficulties or technicalities with which each is faced, and that even the different classes of cotton which are grown and the ways in which they are spun are not sufficiently familiar to spinners and growers respectively. Moreover, to acquire such information hitherto has involved the study of many publications, including annual reports of all descriptions and from all sources, scientific and commercial journals and isolated articles. It is hoped, therefore, to include in this journal not only particulars of the Corporation's activities, and thus to keep those interested informed as to its work, but also to publish information concerning cotton-growing problems throughout the Empire, thus acting as a clearing-house of intelligence collected from different Dominions and Colonies, and keeping Directors of Agriculture and others engaged in cotton growing in touch with development and experiments elsewhere. Further, it will contain statistics as to the cotton crops of the world, together with their qualities and the uses to which they are put. Finally, it is hoped that it may give both spinners and growers a better knowledge of one another's lives, experiences, requirements, and difficulties.

All agricultural departments and cotton experiment stations in the Empire are asked to assist the Editor by sending him their reports at regular intervals. These reports should give particulars of the results obtained from each kind of seed, the nature of the soil, and the climatic conditions under which the cotton was grown. Such reports from each territory, together with statistics of acreage, yield, ginning out-turn, will not only be of value for purposes of comparison, but will show progress made from year to year. It is obvious that at first much will be published that is not new; its value will lie in the fact that it is collected in a form convenient for comparison.

The journal will necessarily deal chiefly with the cultivation of cotton, using the expression in a broad sense as including, for example, all kinds of statistics bearing upon the question, legislation affecting it, and other cognate subjects. A feature will be made of statistics bearing upon cultivation, and it is hoped to make the journal a reliable source from which to extract them; and it is also proposed to pay special attention to any legislation that may be enacted bearing upon cotton cultivation.

The actual cultivators in the Empire, however, are most commonly unable to read, or at any rate to read English, so that the journal will have to become useful to them through the intermediary of the staffs of Agricultural Departments, and the specialists employed by the Corporation. It is hoped, however, that the journal may appeal directly to the small but increasing number of educated men engaged in the planting of cotton. But at the same time it must be realized that its chief circulation, at first at any rate, will probably be in Lancashire, among readers who are anxious to know more about the cultivation of the crop that they consume, and it is hoped that it may be a means of getting them to understand better the work of the cultivators upon whom they are dependent, and *vice versa*. A sympathetic understanding between the two, based upon real knowledge, will help to reduce the difficulties of the present situation. To aid in this, it is hoped to obtain more popular, but reliable, articles upon the actual work of both sections of the cotton industry—growing and spinning—from people actually engaged in these occupations.

With readers of such different kinds, it is clear that the work of editing the journal to please everyone will be a matter of difficulty, unless readers will be so kind as to express their opinions about the matter published, and to make suggestions as to the type of matter which they would wish included; and for such assistance the Editor will feel deeply grateful. The first number is, of necessity, largely "historical" and tentative, but in later numbers it is hoped to make the journal assume more regular features, so that suggestions for its conduct will be of greater value the sooner they are sent in. Communications may be addressed to the Editor at Millbank House, Millbank, London, S.W. 1.

JOHN WANKLYN McCONNEL

(*With Portrait as Frontispiece to this number.*)

BY

W. LAWRENCE BALLS, F.R.S.

THE historian of a century hence, when writing of the cotton industry, will draw attention to striking changes on the technical side in its outlook, organization, and rate of development, which began to be evident shortly after the war of 1914-1918. He will probably be tempted to ascribe these changes simply to the mental upheaval which that war produced; but if his sources of information are adequate he will find that the war was only accessory to a fundamental influence, and that influence was the personality of our late Chairman, John Wanklyn McConnel.

While Mr. McConnel's strong character and enthusiasm were visible to all with whom he came into contact during his phase of social effort from 1917 to 1922, when first the British Cotton Industry Research Association and then the Empire Cotton Growing Corporation were being translated from ideals to realities, yet his remarkable success in giving the cotton industry a new technical organization comparable with its existing industrial equipment was due to more unusual qualifications. I had exceptional opportunities for working with him, from our first introduction in December, 1913, at the Giza Cotton Laboratory in Egypt until his death in 1922, not only as an independent investigator, but as a subordinate and as a colleague, in a curious mixture of relationships. Just as it was said of his own chief, Sir Herbert Dixon, that "the diplomatic service lost a great man when Dixon took to cotton spinning," so one can honestly say that the scientists lost a potential leader when Mr. McConnel followed the same course.

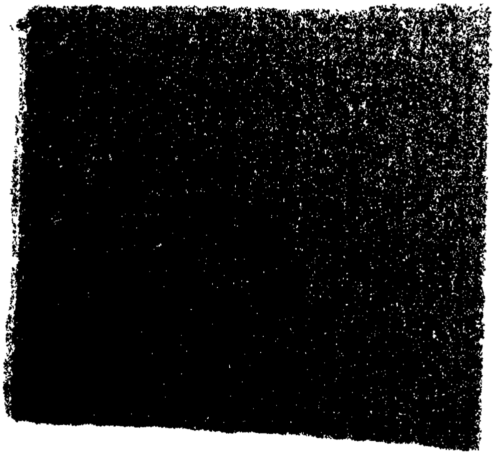
In the first place, he was an incorrigible learner. New points of view, new facts and new subjects, which are anathema to the world at large, were pleasant stimuli for him. He kept the faculty of curiosity, which children and scientists share between them, fully exercised. In the next place, his attitude towards any new discovery—and we made a good many unpublished ones between us—was entirely philosophical; while a "pretty proof," a new "gadget," or a good stiff paradox were of the things which appealed to him, yet his interest always flew beyond them to the next step, whether of discovery or of application. And eventual discovery was more important to him than immediate application, which brings up a third characteristic, his realization of ignorance. We are all apt to think that while theoretical knowledge may be illimitable, its usable fraction is hopelessly restricted by practical limitations; that although we have much to learn about the cotton plant, we already know enough to satisfy all practical possibilities for the next half-century. With this attitude he had no sympathy. His sudden contact with the investigations in Egypt, after he had become thoroughly familiar with cotton-growing practice and practical problems in Mississippi and the West Indies, had no doubt some influence in breaking down the last distinction in his mind between theory and practice; but the same tendency showed inside the spinning mill, where three generations were concerned. To use a machine such as a carding engine and yet not know why and how it worked was more than an annoyance; it was immoral.

Out of this attitude, none too common even in young men, still less so in "successful" men, there followed several consequences which were not merely peculiar to the two organizations he founded, but are—in my opinion—of fundamental importance therein. Behind all the legal, technical, and material complication of both bodies is the implication that knowledge is the first essential. Men can be sent to cotton-growing countries, but they must have knowledge before they can do anything of permanent use; nearly all their knowledge must be wasted, but some fragment will start a new development. Knowledge merely of common information about cotton is desirable, but incidental compared with a general scientific equipment. Hence also comes the Corporation's rather remarkable system of studentships, held without obligation on either side. Similarly with his plan for the Research Association: while staff and equipment were required not only on a laboratory footing, but up to full-scale mill machinery dimensions, they were wanted for purposes of study; an actual constructive development should be handed over to an affiliated company, leaving the proven student still to his studies. It was a misunderstanding on this matter which led to his resignation from the British Cotton Industry Research Association. The abolition of ignorance was to Mr. McConnel the chief social end of man.

Some of these views, tenaciously held, conflicted occasionally with other strong views, and were commonly less evident in public than over the study table; but that they formed the driving power during our seven years' friendship is not in any doubt to me. That individuals could originate, but committees never, was a favourite dictum.

My own pet generalization, that cotton growing and cotton spinning are both parts of one industry, was raised by Mr. McConnel from a speculation to a political reality when the Research Association was being formed; and the convergence of the Association's work towards that of the Corporation, which is now taking place in spite of the temporary divergence when he resigned his chairmanship of the former body, is proof of his insight and, in the broadest sense, of his political wisdom.

My purpose here is to give an impression of essentials rather than to attempt details; but it seems worth while to frame the picture by reference to his habit of reducing a matter to writing. In his case writing certainly made an exact man, and his output of memoranda and letters, usually with a statistical basis, was phenomenal. On the other hand, he complained of being a slow reader; but since I had found on the day we first met that he was far more familiar with the new edition of Willcocks' "Egyptian Irrigation" than I was, this complaint never seemed worth bothering over. I have still a vivid memory of that day among my cotton plants with the cotton spinner who thought his best yarn was not perfect, who picked up my slide rule to make a calculation, who welcomed my heterodoxies about expert grading, who knew the limitations of cotton growing equally with those of cotton spinning, and who yet would admit no justification for complacency because limitations existed at the moment. That I should write his obituary notice was not foreseen.



WILLIAM ROBSON: CURATOR OF THE BOTANIC STATION, MONTSERRAT, 1905-1923

AN APPRECIATION AND SUMMARY OF HIS WORK ON COTTON.

BY

L. H. BURD

THE development of the cotton industry in Montserrat began soon after Mr. Robson's arrival in 1905, and from that time onwards until his death the welfare of Montserrat as a cotton-producing island was foremost in his mind, and the island undoubtedly owes its present status as a producer of high-grade Sea Island cotton entirely to his work.

In the early days, when cotton was a novelty, much time and study had to be devoted to cultural problems. No one knew the best way either to grow or to manure the plant, nor which was the most suitable variety for cultivation under tropical conditions; all such matters had to be investigated before attention could be directed to the improvement of the cotton itself. The task of solving these and kindred problems for Montserrat naturally devolved on Robson, and, although in work of this type one problem naturally leads to another, so that one can never be said to have attained or even approached the goal, yet the results achieved by Robson show abundantly that he was not content to stand still, but that he travelled far along the road to success.

It will greatly clarify the consideration of his work if the subject be divided into four headings: (1) Selection; (2) Diseases; (3) Spacing; (4) Other lines.

THE SELECTION WORK.*

The beginning of the improvement of plants by selection was made in 1908, when the seeds were sown from three plants which were selected the previous year, and it was in this sphere of work that Robson was most successful. The ultimate success attained is all the more surprising because until about 1921 all questions of quality were decided simply on brokers' opinions (which were frequently conflicting), and the necessity for rigid self-fertilization was not realized until 1916, so that for a long time there must have been frequent natural intercrossings between his strains. Clearly, his superiority over other workers was largely due to his natural ability, akin to genius, for picking out from a complex mass the most suitable plants, and to his being able, like the successful animal breeder, to build up clearly in his mind a picture of the ideal type.

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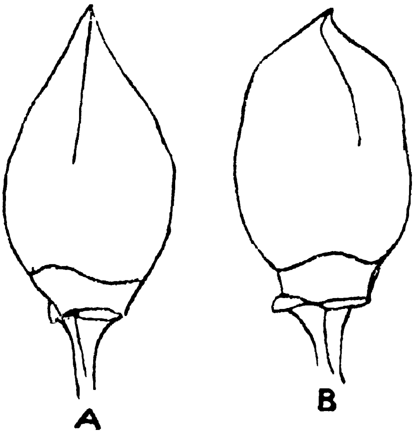
* "The progeny row" system was used in propagating the pure strains, the "progeny row" consisting of the offspring of a single plant last year.

The work, as it progressed from year to year, was accompanied by a gradual but steady expansion of ideas, not only from the selection point of view, but from other aspects as well. In 1910 laboratory examinations of the lint and seed characters were made for the first time, and future selection work was largely based on these. At this time, too, samples of various types were sent to Manchester for spinning tests, thus marking the beginning of a sympathetic feeling between spinner and grower.

By 1912 as many as twenty different strains had been isolated, and it became clear that many of these would have to be discarded, not only for reasons of space, but also because of their economic unsuitability. As soon as this weeding out of strains had begun, one of them—the H. 9—stood out as being superior to the others, not only in lint, but also in yield characters. The actual origin of the variety is unknown. All that can be said with certainty is that it came among some seed imported from the Superintendent of Agriculture in Barbados. In 1917 the new strain—H. 23—was separated from it, and gave an even higher yield. The shape of the boll was also distinctive, and is now known in the West Indies as the "Montserrat" type of boll, since it is grown extensively over the island. It is shown in the figure contrasted with the St. Vincent Superfine V. 135.



A = St. Vincent, Superfine V. 135. B = "Montserrat" H. 23.

The bulk of the Montserrat cotton at present consists of H. 9 or H. 23 types, and is now recognized on the markets as a more or less precise type. It has been fortunate that the conditions where these strains were started have been more or less the same as those which obtain on the estates, so that the cottons which behaved well in the Experiment Station have also succeeded in the cotton-growing districts of the island. In other places this is often not the case, and much harm has been done by recommending varieties which have not previously been tried on that particular type of land.

DISEASES.

Montserrat was, until the arrival of the pink bollworm, remarkably free from serious cotton pests, either fungous or insect. In the earlier years leaf blister mite was prevalent, but now it causes little trouble; probably the rigid observance of a " close season " has been responsible for keeping it in check, and at the same time the process of selection has tended to isolate a semi-immune type.

The combined efforts of Paris Green and the Jack Spaniard have been successful in keeping the ravages of the cotton worm (*Aletia argillacea*) down to reasonable proportions. Attempts—more or less successful—were made to supplement the local species, *Polistes crinitus*, by *P. annularis* from St. Vincent.

The cotton stainer (*Dysdercus spp.*), by means of which the internal boll disease is spread, has also been checked, though by no means extinguished, through enforcing the close season as rigidly as possible, and thus partially exterminating the insects between one crop and the next, and by destruction of the wild host-plants on which the stainers feed. Naturally, a legislation enforcing such a close season can easily be circumvented either intentionally or by carelessness, and success can only be when the goodwill and the co-operation between the planters and agricultural authorities has been obtained: in this respect Robson is particularly to be praised, for he was one of the few scientific agriculturists who have enjoyed the complete confidence of the purely practical man.

The soft rot (*Phytophthora spp.*), which is so serious in St. Vincent, does not seem to do much damage in Montserrat, though there are indications that the results of some of the spacing experiments have been upset by its influence. One must remember, however, that in Montserrat rainfall is not excessive, and that these fungi are favoured by humid conditions.

The presence of the pink bollworm (*Gelechia gossypiella*) was discovered by Robson on November 5, 1920, and it was thought by many that its arrival must mean the complete ruin of the cotton industry. However, the drastic precautionary measures advocated by Mr. H. A. Ballou, the entomologist of the Imperial Department, and diligently put into operation by Robson, have succeeded in keeping the pest within reasonable bounds.

SPACING EXPERIMENTS.

Considerable attention has been given to the question of spacing cotton both for plants in the row and for distance between the rows. All the experiments, however, have been rather of the " hit or miss " type, and have not finally settled the question or enabled one to lay down any generalizations about the effects of spacing on the plant itself. On the whole, the evidence seems to show that a moderately close spacing, say about 5 feet between the rows and 18 inches in the row, will give the best result. Sometimes very close spacings indeed have given enormous crops, and at others have proved a disastrous failure. Possibly the very humid atmosphere that would exist among the crowded plants in a rainy period would favour unduly the spread of fungous diseases; and so, although the number of flowers produced would be large, a great many of these would fail to mature and the expected high yield not be obtained. It is unfortunate that in the experiments concerning this problem which have been conducted in Montserrat the various factors at work have not been properly analyzed and the plots not repeated frequently enough, so that false conclusions have been drawn from inconclusive data. In 1917-1918 planting two plants per hole gave an increase of 20 per cent. in the yield, but even this experiment has not been successfully repeated, and the whole matter is still *sub judice.*

OTHER LINES.

In addition to the work already described, Robson's activities extended in many other directions. Although varied and persistent, they have unfortunately left few results of a permanent nature, but they bear evidence of his untiring energy and breadth of outlook.

The manurial experiments were carried out over a large number of years, and it is to be regretted that he lacked the statistical training so necessary for their proper design and interpretation. Brief accounts of these experiments are given yearly in the West Indian Botanical Station Reports and also periodically in the *West Indian Bulletin.*

Mr. Robson was quick to realize the far-reaching importance of

Mendelian principles of inheritance in plant-breeding, and latterly not only conducted the selection work with these principles in view, but also did some work of a purely Mendelian character—*e.g.*, he examined the mode of inheritance of the "all fuzz" character of cotton seeds. Again, to revert to the early days, he was keen on importing and testing many varieties, including three Egyptian types, as well as cottons from other West Indian islands. A little later (when all these importations had been abandoned) his experiments as to hoeing and the time of planting were useful and encouraging.

We have no space to comment further on other aspects of Mr. Robson's work in connection with cotton cultivation. It is certain, however, that in the particular sphere which he had made his own, he has left a gap which it will be very difficult to fill, and his loss will be felt as keenly by those responsible for the appointment of his successor as by those who knew him personally and enjoyed his hospitality.

THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE

BY

SIR FRANCIS WATTS, K.C.M.G.

Imperial Commissioner of Agriculture in the West Indies and Principal of the College.

THE greatly increased use of tropical products during the last fifty years, their growing importance as articles of commerce and daily life, together with the changes that are taking place in their modes of production, have led to repeated suggestions that there should be institutions where matters relating to the production of these commodities should be regularly studied and taught. Great progress has been made in recent years in the development of tropical Departments of Agriculture concerned with the study and with the introduction of crops in tropical countries, and charged with the duty of supplying information to cultivators as to the best crops to grow and the manner of growing them, including their treatment in the field and the means of combating the many pests and diseases to which tropical crops are liable, but hitherto there have been few institutions in the tropics directly concerned with the teaching of the science and art of agriculture. For years past there have been suggestions that there should be within the tropics Agricultural Colleges to perform for those regions the functions so well carried out by the Agricultural Colleges now so numerous in countries having temperate climates, whose work is regarded as vital to the agricultural interests and developments of those countries.

These repeated demands for a tropical Agricultural College within the Tropics culminated in 1919 in the appointment by Lord Milner, then Secretary of State for the Colonies, of a Committee " to consider whether it is advisable to found an Agricultural College in the West Indies, and, if in the Committee's opinion the answer to this question is in the affirmative, to make recommendations in regard to the situation, constitution, management, scope, finance, staff, buildings, and any other matters which, in the opinion of the Committee, require to be considered in connection with the founding of the proposed College."

The Committee reported favourably, and the proposal to establish a College met with favourable consideration on reference to the several

West Indian Colonies, the majority of the Colonies pledging themselves to contribute to the support of the College; while certain of them, notably Trinidad, Antigua, and St. Kitts-Nevis, in addition, made substantial contributions towards the cost of erecting and equipping the necessary buildings. In the case of Trinidad, the contributions for this purpose were made by the joint action of the planters of the Colony, who voluntarily agreed to the levying of an impost on the principal articles of export in order to furnish a fund of some £50,000 for the purpose, this impost being collected by the Government under legislative enactment. In addition to this, the Government of Trinidad presented to the College a fine site of eighty-four acres at St. Augustine, situated about seven miles to the eastward of Port of Spain on the Eastern Main Road and adjoining the Trinidad Government Railway; a station conveniently exists at the entrance of the College grounds; access is thus easy both by road and rail. The site is within about a mile of the Experiment Station of 143 acres belonging to the Agricultural Department of the Colony, and adjacent to this station is the Government Stock Farm. Advantage is taken of these institutions for purposes of instruction. The site is an ideal one, being level, well drained, provided with a good water supply, and admittedly one of the pleasantest and healthiest residential districts in the Colony.

As for the present the College is non-residential, the existence of ready means of communication is of importance, for it enables such students as cannot find accommodation at St. Augustine to live in Port of Spain and to travel backwards and forwards by train.

It is not desirable to burden the present communication with details concerning the early stages of the formation of the College; suffice it to say that by making strenuous efforts it was found possible to repair and adapt certain buildings existing on the site and to open the College for teaching purposes on October 16, 1922.

It is intended that the College shall fulfil several functions. In the first place, it is to provide training for those who intend to undertake the work of tropical planting as a means of livelihood, to provide for the training of young men leaving the secondary schools of the Colonies or the Mother Country in order to fit them to become intelligent planters and directors of the business of plantations in tropical Colonies, whether within the West Indies or farther afield. By means of a systematic course of study it is hoped to turn out young men whom the directors and managers of tropical plantations will be glad to employ from the fact that they have an intelligent appreciation of the work of a plantation, of the requirements and manner of dealing with the crops that are grown, and of the labour conditions attendant upon the work. It is not anticipated that the College can turn out skilled and experienced planters, for years of practical application are essential for this, but it is expected that it can, and will, turn out a body of intelligent young men who, having a good knowledge of the fundamental facts relating to plantation work, will be apt to learn the more intimate details of plantation management and who, from their training, will be able intelligently to carry out and direct the work entrusted to them by older and more experienced men. It is anticipated that the steady inflow into plantation work of a body of young men familiar with the fundamental scientific facts underlying tropical agriculture, imbued with habits of observation and study, capable of understanding and using current scientific agricultural literature, will tend greatly to help to advance tropical agriculture and to give greater precision to its work and outlook.

In addition to this, facilities are being provided for giving instruction to young men who have been trained in agricultural subjects in universities and colleges in the Mother Country or the Dominions, who, having general knowledge of agricultural matters, desire to obtain special knowledge of agricultural matters in their tropical aspects.

This opens up several fields: there are those who desire a general training in order to enable them to undertake planting work in the Tropics as overseers or managers or directors of tropical estates and enterprises. There are also those who require information regarding the cultivation and production of particular crops, such as sugar, cotton, cacao, rubber, spices, oils, fruit, and many others of tropical importance, with a view to taking part in and ultimately directing some special branch of work. Again, there are those who wish to be trained to undertake work as plant pathologists, whose duties lie in the direction of controlling plant pests and diseases or in investigating and finding means for controlling new pests and diseases which from time to time make their appearance and threaten the welfare of some industry.

Finally, there are students who desire to undertake investigations into matters lying outside the range of routine agricultural practice, who wish to explore new fields connected with soils or with plants in their tropical relationships, who will find ampler scope and more suitable conditions in laboratories situated within the Tropics than are to be found in the laboratories of colder countries. From this work of research it is expected that useful additions to knowledge will result.

Furthermore, it is the desire and the intention of the Governors of the College that research in various directions shall be undertaken by the members of the College staff. Already much useful research work has been done by members of the staff of the Imperial Department of Agriculture, and many papers of scientific interest have been published by them; the increased facilities which the College affords will undoubtedly prove greatly stimulating in this connection.

Such are some of the aims and objects of the College; the work of the first session is nearing completion, and plans have been laid for that of the second session, which begins on October 1, 1923.

The first session has been attended by eleven students, entered for the three years' Diploma Course in General Agriculture, the main object of which, in the first year, is to lay a scientific foundation for the proper understanding of advanced agricultural technology and practice in the second and third years. Five other students are attending for special work and instruction; of these latter two hold studentships provided by the Empire Cotton Growing Corporation for the purpose of special study of matters relating to cotton.

While the main course of instruction will be concerned with the teaching of the general principles of agriculture in a broad sense for the purpose of training those whose business it will be to carry on the work of tropical plantations, much attention, and that in increasing degree as time goes on and facilities become available, will be given to study and investigation regarding special aspects of agricultural and allied problems. It is anticipated that a prominent part of the College work will be concerned with the training of plant pathologists, whose services are in great demand throughout the Tropics, for tropical crops are subject to the attacks of pests and diseases which often threaten the very existence of important industries; these are caused by fungi, insects, and other organisms whose life-histories in many instances are only now becoming understood. Indeed, many of the pests and diseases met with in recent years affecting tropical crops are caused by agencies new to science, so that special and extensive studies have been necessary before rational means of combating them could be devised. Furthermore, the continued direction by scientifically trained men is necessary for the supervision of the work of control. Matters of this kind are taught with difficulty in institutions lacking immediate contact with the crops concerned, but they can be taught to great advantage in an institution, such as this, situated within the Tropics and having access to these crops. Such training as can here be given should be of great value to those whose future work will be concerned with the control of tropical crops of various kinds in diverse parts of the world, whether this work consists in the direction and management of plantations or in investigating and advising specifically with regard to the control of pests and diseases.

The business of plantation management differs from ordinary farming in many respects; it not only involves the production of certain crops in the field, but also the manipulation of the crop product so as to furnish the finished article or the raw material for consumption in industries in other countries: in this way the tropical planter is often concerned with the carrying out of processes which are in the nature of manufacturing ones. Not only, for example, may he grow sugar, but he must manufacture it for export either as raw material for the refineries, or as a finished product for the groceries, this involving the use of heavy and complicated machinery of great cost, operating in factories often of immense size. Again, the preparation of such crops as cacao, the raw material from which cocoa and chocolate are manufactured, involves fermentation processes on which the quality of the product largely depends, processes which even now are not thoroughly understood, and which provide attractive fields for scientific investigation. In the production of cotton it frequently happens that the tropical planter is required to have knowledge of and often to conduct the work of ginning and baling and the manipulation of the cotton seed; and in the production of the finer grades of cotton he requires to know something of the requirements of the fine spinners and of the manner of marketing the cotton which they use. The growing of rubber necessitates also its preparation as raw material for shipment and manufacture. In few cases is there the simple reaping of a crop, such as a grain crop or a root crop, which is the concern of so large a proportion of farmers in temperate regions.

This preparation of raw materials for export entails for its successful completion a knowledge of markets and of shipping conditions, for it frequently happens that the products of the Tropics are sold under conditions which require skilled knowledge on the part of the producer.

It is hoped to develop the technological aspects of instruction at the College in so far as tropical products are concerned. An important move is being made in this direction by the appointment of a sugar technologist, whose business it will be to give as thorough an instruction as circumstances permit in the processes involved in the manufacture of sugar; in the first place, this instruction will be given in the laboratory and class room, and ultimately in a model sugar factory equipped with all the principal appliances for the manufacture of sugar on a small but adequate scale by modern processes. This promises to be a striking and important development of the activities of the College.

Similarly, it is expected that instruction will be given in the preparation of cacao, of copra, of oils, of cotton, and other tropical products.

Readers of this journal will be particularly interested in the work of the College in its relation to the cotton industry. It is anticipated that much may be done here which it will be difficult to achieve elsewhere. As already stated, it is proposed to give instruction in the general work of cotton growing; this implies knowledge of the work in the field; the providing and developing the right types of seed and keeping the strains pure; the manuring, weeding, and cultivating of the crop; the control of pests and disease; the gathering, ginning, and baling of the cotton, and the consideration of the methods of shipping and marketing; the disposal of the seed and the preparation from it of oil and cake—a long list of subjects for instruction and study.

In considering the facilities of the College for this work it may be well to point out that the College is based on, and is amalgamated with, the Imperial Department of Agriculture for the West Indies, whose work is still in large measure maintained. This Department was instrumental in introducing and developing the Sea Island cotton industry in the West Indies. In doing this it succeeded in producing strains of Sea Island cotton of great excellence and purity of type, in evolving agricultural methods well adapted to West Indian conditions, in devising means of controlling an unexpected series of pests and diseases, many of which proved to be peculiar to the West Indies and had not been heard of before; in organizing the work of ginning and grading the cotton; and, finally, in co-operation with the British Cotton Growing Association, it studied and developed the methods of dealing in the special type of cotton produced in these islands. The outcome of all of which is that, with the failure of the production of Sea Island cotton in the United States, owing to the disastrous advent of the Mexican boll weevil, the British fine spinners are assured, by the developments that have taken place in the British West Indies, of the continuance of production of that type of cotton on which their industry depends. At the present moment, however, they are unable to use this cotton to an extent sufficient to maintain the prosperity of the plantations on which these results have been achieved.

By the association of the Department with the College the knowledge of these steps in development and of the means by which they have been achieved is preserved in the records of the associated institutions and is available for instructional work. Furthermore, a live interest is maintained by the close association with the work of cotton growing in the several islands and with the investigational work carried on in the Experiment Stations of the several departments of agriculture, and it is possible for students and investigators to keep in touch with what is going on in the commercial, agricultural, and scientific aspects of the cotton industry, and to visit the islands where work of special interest is in progress.

Without attempting to enlarge unduly, reference may be made in somewhat greater detail to some of the work which is implied in the foregoing outline of the steps taken to establish the Sea Island cotton industry in the West Indies.

One line of work was, and continues to be, concerned with the production of the right type of cotton. In this work assistance has been rendered by various fine spinners, who, at the outset, pointed out the requirements of the fine spinning business, indicating the qualities required in the cotton and the defects to be avoided. Starting with this information and with supplies of seed derived from various sources, the officers of the Imperial and Local Departments of Agriculture, working in intimate association with the cotton growers, set to work to improve the types of cotton in cultivation in the several islands, with the result that to-day several islands are each producing a strain of cotton of remarkable regularity and purity, concerning which active work is still in progress with the object of effecting further improvements in quality and in yield.

In addition to this, the Department of Scientific and Industrial Research made provision for research work under the general direction of the Imperial Department of Agriculture, whereby it was possible to engage the services of workers of special attainments for the investigation of special problems relating to cotton. This work has been carried on principally in the island of St. Vincent, which produces cotton of unrivalled fineness, the Government of this Colony actively contributing to this work by providing experimental grounds and other facilities. This aspect of the work in due course devolved upon the Empire Cotton Growing Corporation and is still in progress. This research work has mainly been concerned with the studies conducted by Dr. S. C. Harland into the manner in which the cotton plant builds up and produces its crop, these studies being largely an extension of the investigations begun in Egypt by Dr. W. Lawrence

Balls, and also studies in the manner of inheritance of various factors of interest and importance; of the influence of fertilizers and of environment. Under the ægis of the Corporation, Mr. T. G. Mason carried out extensive physiological investigations mainly concerned with the water relationships of the cotton plant and the soil and their bearing on crop production. Investigational work along similar or related lines is still in progress at the hands of Mr. L. H. Burd.

The papers communicating the results of these investigations have been published chiefly in the *West Indian Bulletin*, vols. xvi., xvii., xviii., and xix., to which reference may be made.

Controlling the many pests and diseases which made their appearance concurrently with the efforts to grow cotton on a commercial scale necessitated a considerable amount of scientific work in order that the industry, which was often severely threatened, might not come to an untimely end. Here, again, space only permits of the briefest reference to the work done in this connection. Insect pests proved troublesome at the outset, and it was necessary to study them in detail, for their life-histories were for the most part unknown. Amongst the troublesome pests investigated by the scientific officers of the Department may be mentioned the cotton worm (*Alabama argillacea*), leaf blister mite (*Eriophies gossypii*), pink bollworm (*Pectinophora gossypiella*), the cotton stainer (*Dysdercus spp.*), and many others, all of which have been extensively studied and means of control devised.

Several fungous and bacterial diseases have caused much damage and have been investigated in detail, notably the boll rots and bacterial boll disease and anthracnose. Special study, extending over several years, was given to the internal boll disease, a disease new to science. After much study it was discovered that it is due to a highly specialised form of fungus which is conveyed to the cotton plants and inoculated into the boll through the medium of plant-sucking bugs, notably *Dysdercus*, thus affording an explanation of the part played by this insect which had been recognized as detrimental to cotton, though the manner in which injury was caused remained for a long time quite obscure. Those interested in these investigations will find them recorded in various papers in the pages of the *West Indian Bulletin*, ranging from vol. xvi. to vol. xviii.

Measures for the control of this disease, based on the knowledge acquired in the course of these investigations, have been put forward from time to time with excellent results. Prominent among these measures is the adoption of close seasons for cotton, seasons during which all cotton plants are eliminated, the old growths being destroyed and no new planting being allowed to take place until the expiration of the close season. To give effect to the recommendations recourse has been had to legislation, which has been enacted on the advice of the scientific workers.

Reference is made here to all this in order to show that the College is in intimate association with the work of cotton production and its problems; the information acquired in the course of the work referred to being accessible in the College records and available for the instruction of students and the guidance of scientific investigators.

While from the foregoing it will be evident that the staff of the College have a valuable store of accumulated experience to draw upon, it is not to be expected that in these early days full efficiency in regard to teaching has yet been reached; still, much that is of value is available and much that is not likely to be found elsewhere. It is desired to strengthen the College resources as rapidly and as much as possible, and it is not too much to hope that within a very short space of time unique opportunities for study relating to cotton will be available, and also similar unique opportunities for the scientific investigation of many of the problems awaiting solution, particularly those relating to the physiology and genetics of the cotton plant.

At the present time there is no commercial cultivation of cotton carried on in Trinidad, so that the College has to rely upon small areas cultivated for experimental purposes for its practical demonstrations of field work in Trinidad; these areas are being increased. Arrangements can be made for students requiring special information concerning the commercial aspects of cotton production to visit St. Vincent and other neighbouring islands where cotton is grown on a considerable scale.

While the instruction that will be given in the general agricultural courses will prove of value to the prospective grower of cotton, it is felt that the College is in a position to give special consideration to the requirements of those who are to be engaged in connection with special aspects of cotton production, such as the selection of seed for the development of new and improved strains of cotton suitable for given localities, and the steps to be taken to introduce these into cultivation and to maintain the purity of the type after its introduction; or the investigation of pests and diseases and the devising of means for their control, including the actual measures themselves, and also the legislative or other regulatory enactments necessary for giving effect to those measures.

In its widest sense the Imperial College of Tropical Agriculture appeals to those interested in cotton, whether in the routine production of that commodity or its extension into new regions with a view to increasing the supply, or the investigation of problems related to the character of the lint, the improvement of existing strains or the creation of new ones, the field problems connected with yield, or the control of pests and diseases, or the facilities which it will afford to students engaged in scientific study of many of the problems relating to the cotton plant and its derivatives.

While special consideration is here given to the facilities for study in matters relating to cotton, the College is also well placed in regard to work connected with other tropical industries, and it is hoped that it will merit and receive support and encouragement from an ever-increasing range of Colonies, communities, and individuals to whom tropical agricultural products are of fundamental importance.

THE INDIAN CENTRAL COTTON COMMITTEE

BY

B. C. BURT, B.Sc., M.B.E.
Secretary, I.C.C.C.

THE Indian Central Cotton Committee, constituted by resolution of the Government of India on March 31, 1921, was created on the recommendation of the Indian Cotton Committee (the touring Commission of 1917-1918 presided over by Mr. J. MacKenna), whose report, published in the beginning of 1919, received such a cordial reception as a clear presentation of the problems involved in the improvement of Indian cottons and the measures required to solve them.

In their chapter on the subject the MacKenna Committee state that the lack of organization of the cotton trade and of co-operation between it and the Agricultural Departments was brought prominently to their notice. At that time there was no one body representative of all cotton trade interests. The East India Cotton Association, another of their recommendations, has since been established and has taken over control of the cotton futures markets, arbitrations, the management of the clearing-house, and other purely trade matters.

But, as noted by the Commission, a further and more elastic organization is required to bring the Agricultural Department, as a whole, into closer touch with the trade. Not only was it felt that a common meeting-ground was necessary, where all persons concerned in the cotton industry could discuss their mutual problems, but that there was a real necessity for such a representative body to give authoritative advice to Government in connection with matters of cotton policy. The Commission had found it necessary to advise the introduction of restrictive legislation to deal with certain abuses, as they felt that without such action these would continue to mar the reputation of Indian cotton in the world's markets and to retard progress. They had before them the history of the Cotton Frauds Act of 1863, and it was clear that direct Government control was ineffective. They thought, however, that by means of a strong unofficial Committee methods of dealing with abuses could be worked out which would be effective without harassing genuine trade.

Since the MacKenna Committee reported, not only have Provincial Governments become practically autonomous with much wider powers, both financial and legislative, than they previously enjoyed, but the improvement of agriculture and the development of industries in each province are now under the charge of a Minister directly responsible to the Provincial Legislative Council. The Central Cotton Committee have devoted considerable time and thought to the adaptation of the MacKenna Committee's recommendations to the changed conditions resulting from the reform scheme. The progress made will be referred to later on.

It was obvious from an early date that, as a purely advisory body, the Central Cotton Committee would not be able to perform adequately the functions for which it was created, and that it was essential that it should possess funds of its own and be in a position to undertake definite measures for cotton improvement. One of the recommendations of the MacKenna Committee was the imposition of a cess on all cotton consumed in Indian mills or exported from India, in order to produce additional funds for research work for the improvement of cotton growing. In the particular form in which it was made their recommendation was unacceptable, as it was not in consonance with the financial arrangements consequent on provincial autonomy. On the other hand, the need for further provision for research was even greater than before. The Central Cotton Committee therefore requested the Government of India to undertake legislation for the imposition of a cotton cess, the proceeds of which would be controlled by the Committee, subject to the general supervision of Government. The Indian Cotton Cess Act became law on March 16, 1923, and provides for a levy of four annas per bale on all cotton, whether exported or consumed in Indian mills, for a period of three years, after which the cess is automatically reduced to two annas per bale. The funds so raised do not pass into the revenues of the Government of India, but are controlled by the Committee, which has been definitely incorporated by the Act and given specific powers of expenditure.

Various changes in the personnel have also been made with a view to strengthening the Committee. It was felt to be more important that the Committee should be fully representative of all interests than that it should be small in size. Since its first constitution as an advisory body several additions had been made to the membership with this object in view; the last of these was the addition of four representatives of cotton growers. As now constituted under the Act, the Committee consists of thirty-eight members, of whom ten are direct representatives of growers, seven represent provincial Agricultural Departments, eight represent Chambers of Commerce and Millowners' Associations, five represent the cotton ginning and manufacturing industry in various provinces and are nominated by the Local Governments, whilst four represent the principal cotton-growing Indian States. There are, in addition, three representatives nominated directly by the Government of India—viz., the Agricultural Adviser to the Government of India, who is *ex-officio* president, the Director-General of Commercial Intelligence, and a representative of co-operative banking. One representative is nominated by the Empire Cotton Growing Corporation.

RESEARCH WORK.

The Central Cotton Committee's programme of research work on cotton was discussed at some length during the debate on the Cotton Cess Bill, and may therefore be looked on as having the specific approval of the Indian Legislature. No inconsiderable amount of work for the improvement of cotton growing has already been carried out, and is being carried out, by provincial Departments of Agriculture, and it was clearly necessary to see that the Committee's proposals not only did not clash with existing organizations, but would definitely supplement and aid them. Generally speaking, though with notable exceptions, the work done in provincial Departments of Agriculture has largely been of immediate local application. Paucity of staff and lack of funds have often resulted in fundamental problems of general importance being passed by in favour of more pressing local problems. But if the development of cotton growing is to proceed without interruption, and if Agricultural Departments in the future—with an ever-increasing demand on their staff for propaganda and the administrative work connected with the introduction into practice of improvements already discovered—are not to be held up for lack of scientific data, the investigation of broader problems must be continuously provided for. The Committee, therefore, issued an invitation to all Agricultural Departments to suggest problems which they could not investigate with their present resources, but for which they possessed facilities if the Committee could assist with funds. In this way a most valuable research programme has been evolved, and it is hoped that this method of working, by taking full advantage of existing facilities in regard to laboratory accommodation, land and buildings, and staff, will enable the maximum results to be attained with the minimum expenditure. The Committee have also urged the necessity of a Central Agricultural Research Institute for cotton investigations. A scheme has been drawn up, to be largely financed from the cotton cess, which it is hoped to bring into operation at a very early date.

It is also intended to make provision, under the direct control of the Committee, for technological research on cotton, and this scheme is far advanced. No such work is being done in India at present, and there is an extreme lack of information in regard to the characteristics of Indian cottons from the spinners' standpoint. Such research is the more necessary as the Asiatic cottons form an entirely distinct group, differing in many respects from the other cottons of the world belonging to the American group. Investigations will be directed not to the study of spinning processes, but to the improvement of the raw material, and the first object will be to provide for the adequate testing of new cottons for Agricultural Departments. The importance of such testing can hardly be overestimated; not only is this the one form of assistance which all Agricultural Departments have unanimously asked for, but the lack of adequate provision for testing cottons before their introduction into cultivation has in the past led to mistakes very difficult to rectify subsequently. The technological laboratory will include a complete experimental spinning plant, where accurate spinning trials on small samples can be carried out under scientific control, and in such a way as to provide the maximum amount of information to the plant breeder. At present there is no way of estimating the value of a new cotton except by actually spinning it; but it is hoped that the thorough investigation of the various physical characters of Indian cottons and their effect on spinning quality will enable laboratory methods to be worked out which will be of direct value to the plant breeder.

Technological research also has a definite bearing on the improvement of marketing. The growing of improved cottons in India is largely a matter of securing an adequate premium to the grower, but, as at present organized, Indian markets are insensitive to improvement in quality. The Central Cotton Committee have throughout felt that the suppression of existing abuses by restrictive legislation is only one step towards improved marketing. In addition, definite constructive action is needed so as to afford a direct incentive in the right direction.

The MacKenna Committee pointed to the existence of gross forms of fraud which have destroyed the reputation of valuable

Indian cottons. They showed that a regular trade existed in the importation of short-stapled cotton for mixing with long-stapled varieties, such cotton often being imported by rail from considerable distances. To deal with this problem they proposed to prohibit the movement of cotton by rail entirely, except under licence, unless consigned to spinning mills or to ports for shipment. An examination of these proposals, and the experience gained of licences for railway transport during the war, indicated that they were too drastic. The Central Cotton Committee, after an examination of all aspects of the problem, preferred an alternative proposal for the prohibition of transport of cotton into scheduled tracts from outside. This scheme presented the great advantage of concentrating attention on those cotton-growing areas which are most worth protecting and where such protection will be effective. It also reduces to a minimum the number of licences required. It is important that the areas selected for protection should, so far as possible, correspond with the programme of the local Agricultural Department for the establishment of superior cottons if the full benefit of the scheme is to be realized.

The Cotton Transport Act, 1923, recently passed by the Central Legislature, embodies the Committee's recommendations and gives Provincial Governments powers to schedule areas for protection. As an additional safeguard, it is provided that no area can be notified under the Act except with the approval of the Local Legislative Council. The Act, once applied, gives comprehensive powers not only for the restriction of transport by rail, but also by road. There is every prospect of its being put into force at an early date in the important long-staple cotton areas in the Bombay Presidency. It is also understood that the Madras Provincial Cotton Committee are actively engaged on the preparation of the details of areas to be similarly notified in the Madras Presidency.

If the Central Cotton Committee's recommendations for legislation for the regulation of gins and presses are also adopted, adequate legislative sanction will exist to enable the mixing of cotton to be stopped. This in itself will undoubtedly be to the direct advantage of the cotton grower. The latter is often blamed by those unfamiliar with Indian conditions, and even by those who should be familiar with such conditions, for the faults of the middleman. The justification for all-India legislation lies in the fact that the cotton trade themselves feel that they are powerless to prevent abuses which prohibit the growers of superior cottons from obtaining the full advantage of their enterprise.

Another complaint against Indian cottons has been the amount of leaf and other extraneous matter which they frequently contain. As a result Indian cottons are unpopular in certain markets, and cottons which in staple and style are suitable for replacing American cotton for certain counts are not competed for. Mills which are designed for the working of American cotton have not the machinery for dealing with leafy Indian cottons; whilst, on the other hand, mills especially equipped for handling Indian cottons are not always prepared to pay higher prices for specially clean cottons. Since most Indian cotton is machine-ginned, any effort to keep cotton clean must begin with the grower, who will only pick cotton clean if he finds that it will pay him to do so. Clean picking means additional expense, and better handling in gins and presses is purely a commercial proposition. Hence the Central Cotton Committee sought for means of supplementing the efforts of Agricultural Departments and Co-operative Societies by affording a general incentive to the delivery at all stages of the cleanest cotton possible. Through the co-operation of the East India Cotton Association a most important change in the Bombay cotton market rules is now being introduced which should have far-reaching effects. The introduction of a mutual *allowance clause for cottons tendered against hedge contracts (providing* " on " allowances for a full class above the standard) by the Bombay Cotton Contracts Board and adopted by the East India Cotton Association was an important step in the right direction. A further advance has now been made by making " on " allowances permissible for two full classes. Since, under the conditions of the Bombay market, actual tenders form a very considerable proportion of the cotton handled, it is clear that this change will have an important effect on secondary markets.

Though only at the beginning of its career, and with much important work in front of it, the Indian Central Cotton Committee has achieved important results. The success already gained is largely due to the whole-hearted support which the Committee has received from its unofficial members and from the bodies whom they represent. Given the continuance of such support, there is every reason to believe that much can be done to make Indian cotton a far more important factor in the world's markets than it is at present.

COTTON IN TANGANYIKA TERRITORY

BY

R. CECIL WOOD

Cotton Specialist in Tanganyika Territory.

THIS article has been written at the request of the Corporation, but I wish to observe that it has been done after less than a year's experience of the Territory, and that confined to two cotton-growing districts only—Rufiji and Morogoro; the former is, indeed, the only district that I can be said to know at all intimately, from the cotton point of view. Conditions in Mwanza are, I believe, very different, and probably a good deal of what is stated here will not apply, though I have endeavoured, by making enquiries and reading, to make the article apply as far as possible, to the whole Territory. *Major Hastings Horne's report to the Corporation may be studied for further information.*

The "Man in the Street," on reading the title of this article, would probably reflect that it was a subject which would not be likely to interest him, as his ignorance of the cultivation of cotton would be about equal to his ignorance of Tanganyika. The readers of this journal may be expected to know, at any rate, something about cotton, but it is likely that their knowledge of the country known in full as the Tanganyika Territory is not very extensive. The complaint is sometimes heard that though the Tanganyika Lake remains in one's mind as a relic of geography lessons at school, yet much of the Territory bearing this name lies far from the Lake, and even borders the Indian Ocean.

The extent of the Territory will be gathered from a glance at the map, but even here there are pitfalls. It covers roughly the area shown in older maps as German East Africa, but is not quite coterminous, as a considerable slice in the North-West has been taken over by Belgium under a Mandate from the Council of the League of Nations, in the same way that Great Britain is administering the rest.

As a Mandated area, there are certain difficulties which need not be gone into here, but the fact undoubtedly makes the work of administering the country more difficult than if it were a full Protectorate in the way that Uganda or Nyasaland is. The Administration is further hampered by the general inexperience of its staff. Nearly all authority is in the hands of the District Administrative Officers, who are all, of necessity, new to the country, if not to the kind of duties they have to perform. On the other hand, the District Officer has more personal authority than officers of a similar standing would have in other countries, partly from the difficulties of communications, and partly from the lack of precedent. These conditions, as I shall hope to show, have a distinct bearing on the question of cotton planting and marketing.

This large area naturally contains the greatest variation in soil and climate, and it is hardly necessary to ask whether cotton *can* be grown. The question should more naturally be, " In what areas can cotton be most profitably grown ?" To this question a complete answer cannot as yet be given. The Territory is not sufficiently well known for its resources to have been anything like thoroughly explored, and the only thing that can now be done is to indicate certain areas where it is being grown, and certain other areas where the recorded experience of the Germans indicates that it is likely to be a profitable crop.

For many years the Germans expended very considerable efforts to grow cotton, both directly as a capitalistic crop and indirectly by stimulating the native to grow the crop for them. In the year before the War, the export of cotton from the Territory was over six million pounds,* a figure which had been attained in just over ten years. Energy was devoted mainly to the production of Egyptian cotton, and the result of the trials seemed to be, speaking generally, that the country south of the Central Railway was suitable for cotton, but that its successful cultivation north of this line was more uncertain, owing to the possibility of rain interfering with the ripening of the bolls. It should be remembered that this was experience with Egyptian cotton, a more delicate crop than the Nyasaland type of Upland cotton which is now being exclusively grown. The Germans were also considerably exercised over a Red-leaf disease which attacked the Egyptian crop.

The statement on p. 33 shows, for the last year (1922-1923), the main districts where cotton was being grown, and the amounts obtained:†

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* *The Cotton Growing Countries*, Int. Inst. Agric. Stat.

† Figures supplied by the Department of Agriculture.

	Lbs. Lint.
Mwanza	1,160,685
Morogoro	848,304
Rufiji	269,493
Lindi	218,032
Dar es Salaam	152,080
Bagamoyo	77,504
Kilwa	39,796
Total for the Territory = 2,870,036	

All the above was planted with "Nyasa Upland," an American Upland type, presumably originally acclimatized in Nyasaland, but the seed of which is now obtained from Uganda. It is a comparatively hardy cotton, with a fair staple, and though not of such a high class as Egyptian, is yet assured of a steady market.

Granting, then, that there are large areas of the Territory suitable for the cultivation of cotton, the next question to ask is, "What are the prospects for the crop in the future?"

There are two lines along which cotton cultivation may develop: it may either be grown on large and compact areas under capitalistic methods, using imported capital, or it may be grown in small and scattered patches by the native. These two methods are not necessarily antagonistic, and, in fact, the differences are bridged by the plantations in the Morogoro area, owned by Greeks or Indians, who are growing cotton on estates of varying size, purchased from the Custodian of Enemy Property during the last two years.

We can derive considerable experience of the capitalistic method from the attempts of the Germans to open up large cotton plantations in various parts of the Territory. "Land was granted in huge tracts to capitalistic companies and on easy terms to small individual planters and settlers, and attempts were made at the same time to force production by natives themselves. The effect of this policy of hasty development, and the incessant demand for the labour of the native which it entailed, was to produce the great rebellion of 1905-1906."* These remarks apply to companies engaged in the cultivation of permanent crops such as coffee, rubber, tree-cotton, or sisal. The cultivation of cotton presented the same difficulties, but with the additional drawback that it is an annual crop, and cannot be grown continuously. There is no evidence to show that, in spite of the subsidies and assistance of the Government, any of the large cotton plantations were earning a fair interest on the capital invested, though in many cases the introduction of power cultivation was too recent to have affected the cost of production. The small settler was probably more successful: he did not usually confine himself to a single staple, and could devote more personal attention to his crops than the larger companies did. The real difficulty was undoubtedly labour, and this took on a more important aspect in the cultivation of cotton, where the cost of cultivation bulked so largely in the expenses of production, for in most of the cotton-producing areas in Rufiji and Morogoro cattle cannot be used on account of the tsetse fly.

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* **Report of the Tanganyika Territory, July, 1921 (Cmd. 1428), p. 34.**

There are still opportunities for the adoption of this system by any individual or company. Most of the ex-enemy properties have been sold, but there remain a few. The general prospects of success are not, however, very great. Most of these plantations will need the expenditure of a considerable amount of capital before they begin to be productive. Labour has become so expensive and so demoralized by the War that in most cases machinery will be a necessity for cultivation, and this means not only the first cost of the machines, but a trained staff to manage them. And it must be remembered that there are no English-speaking, technically trained Africans available for employment, either as agriculturists or as mechanics. Nearly all the work, except that purely manual, will have to be done by Europeans, with the assistance, in part of their clerical work, of Indians or Goanese clerks of moderate ability. These assistants will have to possess a working knowledge, at least, of Swahili, which means delay in getting them to work or making the most of the assistance obtainable in the country; and will have to be provided with properly fitted and netted houses, which will be expensive. Further, crops will have to be found to grow in rotation with the cotton, probably food crops for feeding the labour engaged. These difficulties are not insuperable, but they mean that any scheme will need very careful consideration, and, moreover, cannot be taken up piecemeal: it will be necessary to embark from the start on the full scheme, and on a large scale.

Thus, though there is no reason to doubt that some cotton will be produced—indeed, it is being produced to-day by European companies or private individuals employing hired labour—yet it is out of the question that such production can ever form any but a small part of the contribution which it is hoped that this Territory will in the future make to the cotton production of the world; and it is consequently on the cultivation of cotton by the native that reliance must be placed, while European activity will be confined to dealing with the raw product, from its arrival at the market or ginnery, to its dispatch by sea to its ultimate destination.

Now the native does not particularly want to grow cotton, or indeed anything but his own food crops for his own use, and if he is to do so on anything like a wide scale there must be some compelling force. This force arises from two things: the necessity he is under of paying his Government hut or poll tax, and the personal influence of the District Administrative Officer, who has been instructed by the Government to do all he can to encourage the planting of cotton. Left to himself, the native, who has, in general, little knowledge of currency or the meaning of prices, would be content to cultivate, or rather to get his womenfolk to cultivate, his "shamba," or little holding, with his ordinary food crops, millet, tapioca, or beans, exchanging any surplus with the local Indian or Arab trader for a piece of cloth or the blade of a hoe. But he must raise cash to pay his tax, and there are two ways of doing this: either he may go out and work for a cash wage for someone else on a plantation, or he may grow cotton, groundnuts, sesamum, or other exportable crop for sale, and of these last cotton seems for many districts easily the most profitable. If, in addition to this, the "Bwana Shauri" (the Administrative Official), who exercises enormous influence through his village officers, collects them together and harangues them on the benefits to be obtained and the precautions to be taken, and in addition presents them with seed gratis, and promises them a market for their cotton when ready, a good deal will probably be grown. And so, as one goes about the country, one sees little patches of cotton, many of them only a few yards in extent but in the aggregate representing quite a fair acreage, so that the production of cotton this year in the Territory will be over 2½ million pounds.

These shambas are cultivated on a very low standard of agriculture: the land is cleared by hand of the grass and trees which have sprung up on it—for most of the land is not kept under permanent tillage—and this refuse is collected and burnt: the land is then lightly dug over, and at the advent of the rains holes are dug at random with a light hoe, into which four or five seeds are dropped (sometimes as many as fifteen go into a hole, a method of getting rid of excess seed passed on by a zealous official). But it has been indicated already that the native is a docile individual, and it is surprising what results the little instruction that the very exiguous Agricultural Department Staff have been able to give have already effected. Cotton may be seen sown neatly in lines of almost perfect straightness, carefully hoed, and, as we shall see, if not picked absolutely clean, at least carefully picked over before being brought to market. The extent to which this propaganda work can be done is limited by the staff of the Department, and there is no doubt that an increase of the latter would be followed at once by an increase in the quantity and quality of the cotton grown in the shambas. Moreover, there is room for a very great deal of experimental work, in the way of improvements in methods of cultivation, ascertaining the correct time of planting, selecting seed, methods of thinning, and so on, which at present cannot be attempted with the available staff. Experience is being gained at Mpanganya, on the Rufiji, and at Morogoro, at both of which places there are, or rather were, agricultural stations in German times. The main difficulty in the former area, where the soil is a very deep and fertile alluvium, is to cope with the terrific growth of weeds, which are expensive to keep removing, but as settlement becomes closer, and the land tends to be kept permanently under crops, this difficulty will become less. Another difficulty felt by the shamba owner is the great depredation caused by wild animals: elephant, buffalo, hippopotamus, eland, and pig all causing considerable havoc in places. Possibly a more rational policy than the careful preservation of many of these destructive pests will result in an improvement in this respect.

Having grown his cotton, the next consideration for the grower is the marketing of it. It must be remembered that the price of cotton has fluctuated very considerably in the course of the last few years, and that the price buyers can afford to pay will vary throughout the Territory, according to the difficulty of transport to the ginnery and thence to the port of shipment. Moreover, the native is generally very ignorant of markets and the laws which govern prices, while he is suspicious of all fluctuations in price, whether natural or artificial. This difficulty was met in German days by the fixing of a guaranteed price, and the purchase at that price of all cotton brought to it, by the Kolonial Wirtschaftliches Komitee, a body resembling in its functions the British Cotton Growing Association. For various reasons it has not been found practicable to continue this practice, and so long as the present high prices obtain little difficulty in this way will be experienced, but the matter will doubtless need careful consideration if and when a fall occurs.

At present, in order to ensure the grower a fair price, the Government have instituted a series of Government auctions, at which the cotton brought in is, after "grading" by a Government official, put up for auction under due precautions; in other cases, certain buyers are licensed, and they only are permitted to deal in this commodity. In any case, Government keeps complete control of the seed, with a view to ensure that only pure seed of a good quality is used for sowing in the following year. Both systems of marketing are on trial, and modifications will no doubt be necessary before they are in full working order; but it may not be out of place to describe a typical auction in the Rufiji District, which was responsible last year for 269,493 pounds of cotton, all of which was sold at one or other of the auctions (for the system of licensed buyers has not been adopted here) held from September to December last year.

The auction opens at 10 a.m. on the first of the three appointed days. The District Agricultural Officer will have come in by road or canoe, the previous day, and will be camped in his tent under a tree on the outskirts of the village. The sellers will begin to arrive at an early hour, and will come in throughout the day, for though some of them live close, for others it may be a two-days' journey. The cotton (kappas) is brought in, in every conceivable kind of receptacle: old gunny-bags, matting bags of various ages, shapes, and sizes, collapsible baskets, even cloths are used, and in quantities from a couple of pounds to a full man's load: it is seldom that a single man's cotton is more than a single load. Paper tickets, numbered consecutively, are given to these men by a clerk, who writes their name and their father's name on the slip at the time, the latter a necessary precaution in a country where the names Sefu, Mohammed, Ali, Salim, and Abdallah would probably account for half the population! Although the queue habit is a novelty, every man—or woman, for they, too, bring in their quotas—must form up into a line and file past first the weigher and then the classifier, and, of course, later on in the day, the disburser of what can in this country hardly be called the "needful." Weighing is done on a spring balance, with two stalwart assistants to lift the bags, which, in defiance of the Government standard load of 45 pounds, sometimes weigh up to 100 pounds, on to the hook, and the weights are called out in kilogrammes, with a rough deduction for the weight of the bag or basket. All cotton is turned out on the floor of the store for the inspection of the grader, who classifies it as "safi" (clean) or "ghafi" (dirty), and the two heaps grow rapidly as the hours pass. The "auction" in this district is for the most part the acceptance by the District Officer of the price offered by the only purchaser: in one or two cases there has been a certain amount of bidding, owing to the competition of Indian traders who are established in the lower reaches of the valley. The necessary calculations are soon made, and in the afternoon the queue is again formed, and the natives file past the table and receive their money. With the numbers that have to be dealt with, it is not to be supposed that mistakes do not occur, but wonderfully few complaints are received, and these are invariably settled before closing for the day. With three Europeans, and clerical assistance to write and issue the chits, as many as 400 individuals can be dealt with in a day; the limiting factor at present being the time it takes to extract the cotton from the bags in which it is brought: the matting bag of the country is mostly shaped like a gramophone trumpet, with the opening at the neck! To have half a dozen men at a time getting their cotton ready for inspection implies a good deal of space, and, besides, tends to spread out the cotton, which ultimately has to be collected in a heap, and thus causes unnecessary handling. The proportion of second-quality cotton is, speaking generally, quite small. It depends, of course, on the way the cotton has been hand-picked before it has been brought in, but it also depends on the personal opinion of the grader. The actual instructions, as issued, are that Grade I. is to consist of "clean white cotton," and if this were taken literally the first grade would be relatively small. This is not, however, a matter of great importance, as the buyer sees just what he is buying: the risk is that with only two grades, if one is kept too high, the second may be unnecessarily lowered by the inclusion in it of some cotton which only just comes within the limit of the definition "marketable cotton." To have three grades is probably not practicable in the present state of organization of the country and the trade.

As has been indicated above, the opportunity of the European lies in the handling of the cotton from the time it arrives at the market to the time it is put on board the steamer for its ultimate destination. There is probably a sufficiency of gins in the country at present, but as the crop is more widely grown more will certainly be required, and, in any case, many of those now at work were originally installed by the Germans, and have suffered greatly from neglect. Most of them will need extensive renewals before long. It is essential for the reputation of the cotton of the Territory that the ginning and baling trade should be in the hands of reputable firms: some Tanganyika cotton was sold in Manchester at the end of last year, samples of which were returned to the purchaser here for examination—it had been ruined by watering before baling.

The one great difficulty to be faced is that of transport, and this affects every aspect of the question. The grower may have to transport his cotton a long way to the auction. As the cultivation of the crop extends more auctions can be held, or permanent markets organized, where regular buyers, holding Government licences, will buy from him. The native, when it is announced that an auction will be held on three stated days of the month, does not grasp that this really means what it says, and as often as not he waits to get the news confirmed by someone, perhaps bolder than himself, before he rouses himself enough to make a start. As the same great thought has occurred to others, there is generally a great rush of sellers from noon onwards on the second day, with the result that the third day cannot dispose of all who come, and some have to wait till the next auction, for it is not possible for the Agricultural Officer to wait, tied as he is to a programme of auctions which account for his days for many weeks ahead. The grower is thus discouraged, but until the staff of the Department is increased, and there are more reputable dealers in this commodity in the country, it is difficult to see an immediate remedy: the trouble will be cured by the gradual extension of the auction or other market system.

From the auction to the gin may be a considerable distance, though again, as the intensity of cotton cultivation increases, this will remedy itself. From the ginnery to the port of shipment is the stage which now adds so much to the cost of the raw material, and for a great part of the Territory, at any rate, puts the cultivation of cotton out of court entirely. There are only two railways—the Central and the Tanga. The latter does not serve a cotton-growing area, or one in which, so far as is known at present, cotton is ever likely to be grown extensively. There are considerable areas of cotton grown along the Central Railway, at Kilossa (400,000 pounds), and Morogoro (450,000 pounds): it is probable that the railway is the predominating cause of the cotton being grown in these areas. But the whole of the Mwanza cotton (900,000 pounds) has to find its devious way to the sea at Mombasa, by going north round the Lake Victoria Nyanza, and then right over the highlands of Kenya by the Uganda Railway. The Rufiji, which possesses natural advantages of soil and climate which make it an ideal cotton-producing tract, has no rail at all, and all cotton has to be got down the river in dug-out canoes—and to find one large enough to take even a small bale of cotton is not easy—to somewhere near the mouth, where it can be put on a dhow for Dar es Salaam, where it has again to be transhipped to an ocean-going steamer. The canoes, meanwhile, will have to be got back again up the river against the current, at a rate which will not exceed as a rule ten miles a day, and in the rains, when the river is in flood, will not be more than five. Formerly, in German times, a shallow-draft steamer plied up and down the Rufiji and towed upstream the empty flats which had floated the cotton down to the ocean-going steamer which loaded at the mouth, but it may be long before such a development will become a commercial proposition, as it almost certainly was not to the Germans. In the Lindi area, where cotton has been extensively grown, and where there is now a possibility of considerable expansion, the little narrow-gauge railway is not now running, and all cotton will presumably be brought into Lindi itself, which is on the sea.

Until the trade of the country shows very great improvement it will be useless to think of much railway development. A good deal might be done in the way of dry-season earth roads; there is no reason, for instance, why the journey to the Rufiji District from Dar es Salaam should not be made by car in a single day—the distance is a little over a hundred miles, a feat which has once been accomplished—instead of on foot, or in a chair, or a mono-wheel, a journey which may take six days. Such a road, which should not be expensive—it practically all exists at present, except for a few streams to be bridged and a few gradients to be improved—even if it does not do anything to aid in the transport of cotton, will at any rate make the district more accessible; it will enable a business firm to keep more in touch with its representatives or assistants in the Rufiji, for instance, while the speeding up of letters would in itself be a valuable asset.

And yet, with all these handicaps, one cannot help feeling that the prospects are good. It is, of course, true that prices are high, and from one point of view this is a pity. As has been pointed out above, the native is very suspicious of fluctuations, and when the price drops, as it must sooner or later, he will be tempted to think, as he has before, that he has been the victim of a conspiracy which first of all tempted him to grow the cotton at a high price and then took advantage of him. The Agricultural Department would probably feel they were on safer ground if the amazing expansion of the last two years, which some districts have shown, had taken place with a more normal market price. Let us look at some of the prices paid last year. They run from 15 hellers a kilogramme to 27 hellers for seed-cotton. A heller is $\frac{1}{50}$th of a shilling and a kilo is 2·2 pounds. Taking the proportion of seed-cotton to lint as three to one—it is really a little more—these prices represent, without including the cost of ginning, from 5d. to 9d. a pound of lint; the balance available for baling and freight can be worked out from current market prices in Manchester, and it will probably be found that there is a sufficient margin for a satisfying profit even if the price were to drop considerably.

We have no means at present of knowing at what price the native will be satisfied with growing cotton. In the almost complete absence of trade which exists in many parts of the Territory, such a term as "cost of production" has no meaning, and, in any case, where labour has not to be paid for, but is that of the grower and the members of his household, exact figures are never very easy to give. Even for production under capitalistic conditions it is difficult to state costs; there has not yet been built up a sufficiently large body of information which shall include fluctuations due to season, soil, and labour. Careful records of costs are now being kept at the Government Agricultural Stations at Mpanganya and Morogoro which will throw some light on this question.

That the cotton is good is undeniable, and that it can be improved is equally certain. No selected seed has ever been grown on a marketable scale; the Germans started selection work at Mpanganya, but the selections had not got beyond the stage of trial and comparison. The seed used up to the present has usually been the result of importations of varying age from Uganda; it is of fair quality, but consists of a mixture of types—the effect of the Egyptian cotton formerly grown has not been wholly obliterated.

Conditions generally will improve, but the pace must not be forced. It was undoubtedly a desire to exploit the country too rapidly that led the Germans into difficulties, and the cultivation of this crop ceased as soon as the hand of authority was relaxed. So it probably would to-day, if the encouragement of the "Bwana shauri" were to stop. But as, year after year, the native grows his cotton and takes it into a market to exchange it for cash, he will more and more be tempted to continue the process of exchange, and with his money purchase some small article of luxury from the shops that are certain to follow the markets, until in time such things as lamps, leather belts, aluminium cooking vessels, gaily printed cloths, and so on will cease to be regarded as luxuries, and will take their place in his scheme of existence as necessities, and the day when that happens the money-making crop has come to stay, and of all money-making crops that the native can grow cotton has a very good chance of taking first place.

BROKERS' REPORTS AND SPINNING TESTS UPON SAMPLES OF TANGANYIKA COTTON

SAMPLES of Cambodia cotton, and of the cotton of American Upland type grown on the Rufiji River, were sent to the Corporation by their cotton specialist in Tanganyika. Attached are the brokers' reports and valuations, together with detailed accounts of the spinning tests carried out by Dr. W. L. Balls, F.R.S. The thanks of the Corporation are due to the Fine Cotton Spinners' and Doublers' Association for their kindness in giving permission for these tests to be carried out at their experimental mill. The Fine Spinners' Association have also decided to allow such tests to be carried out for the Corporation on future samples of Empire-grown cotton, and the Corporation welcome this opportunity of acknowledging their courtesy in this matter. The opportunity of being able to obtain through the Corporation reports on thorough spinning tests carried out on samples submitted will doubtless be highly appreciated by Directors of Agriculture.

BROKERS' REPORTS ON SAMPLES OF COTTON FROM TANGANYIKA TERRITORY.

SAMPLE OF CAMBODIA COTTON.

Classification.—Clean and good colour, staple 1 inch to $1\frac{1}{16}$ inches, rather rough.

Value.—50 points on.

Based on current month (December, 1922), futures at 13.85d.

SAMPLE OF COTTON FROM RUFIJI DISTRICT.

Classification.—Very good colour, staple $1\frac{3}{16}$ inches, regular and strong.

Value.—200 to 250 points "on."

Based on current month (December, 1922), futures at 13.52d.

FINE COTTON SPINNERS' AND DOUBLERS' ASSOCIATION,
EXPERIMENTAL DEPARTMENT,
July 18, 1923.

SPINNING TESTS: TANGANYIKA 1922 CROP.

(JUNE-JULY, 1923.)

The long-delayed tests on these samples have now been completed, with the following results. All operations have been conducted in the Spinning Section of this Department.

DESCRIPTION OF SAMPLES.

Cambodia A.
Cambodia B.
Rufiji Delta.
Rufiji Valley.

METHOD OF SPINNING.

Carded only, not combed. Owing to the small size of the samples the tests were begun at the Card without previous scutching. The same Jack roving was spun into 36s twist on the ring frame and 42s on the mule. In the case of the Rufiji samples an additional mule test was made with extra twist.

WASTE (TOTAL LOSS AT CARD).

Cambodia A	11·4 per cent.
Cambodia B	10·2 ,,
Rufiji Delta	8·1 ,,
Rufiji Valley	7·4 ,,

It will be seen that the Cambodia is markedly inferior to the Rufiji, the difference of 3 per cent. in the amount of waste being quite appreciable.

STRENGTH OF YARN (BY LEA TESTS).

The following figures are based on eight lea tests made on each sample for each spinning; the strengths are corrected to nominal count by the correlation method.

36s *Ring Yarn: 25 Turns per Inch.*

Cambodia A	60 pounds.
Cambodia B	59½ ,,
Rufiji Delta	70 ,,
Rufiji Valley	71 ,,

The strength for Rufiji is, I believe, quite good for these counts; about 78 pounds would be a standard.

42s *Mule Yarn: 24 Turns per Inch.*

Cambodia A	34 pounds.
Cambodia B	35 ,,
Rufiji Delta	48 ,,
Rufiji Valley	47 ,,

The same bracketing of the two varieties appears as before; but the percentage difference between the Rufijis and the Cambodias is now much increased.

The strength of the Rufiji samples has, however, come down much further below standard, which at this count we might take, for purposes of comparison, as 66 pounds. In order to see whether this was due to twist, a respinning of the Rufiji samples was made with 30 turns per inch, and the strength was thereby reduced to about 43 pounds for both samples.

DISCUSSION OF YARN STRENGTH RESULTS.

It would appear that the Rufiji samples can be spun up to the neighbourhood of 36s Twist and give good quality yarn, but that beyond this point their strength falls off.

The Cambodia samples, on the other hand, appear to be forced too far to give their maximum strength, even at 36s, and in all probability they should not be employed above 30s.

It should be understood that the results are obtained from samples which are rather too small for effective investigation; but we shall be pleased, if it is so desired, to repeat the tests on this year's crop and look more closely into the limits of usefulness suggested by the present tests. It is, at any rate, evident that the Rufiji cottons are decidedly superior to the Cambodias, and that there is no significant difference between the two samples of Cambodia or the two of Rufiji.

W. LAWRENCE BALLS,
Chief of Department.

COTTON IN TANGANYIKA

" Baumwollbau und Züchtung in Deutsch-Ostafrika." B. Wunder, formerly Agricultural Expert in Mpanganya. *Der Tropenpflanzer,* vol. xxvi., p. 111, 1923. Bibliothek W. Busse, Potsdamerstr. 123, Berlin, W. 35.

This is a paper that no one interested in cotton in East Africa can afford to ignore, and the notice of it has been transferred to this place in order to draw attention to it in connection with Mr. Wood's paper. The writer begins by pointing out that the regions best suited to cotton in Tanganyika are those with a single period of rainfall in the year, mostly lying in the south of the colony, such as the districts of Rufiji, Kilwa, Lindi, Songea, Langenburg, and the south-west part of Morogoro with Kilossa and Tabora, while further north there are two rainy seasons in the year, and only Mwanza and Bagamoyo-Sadani have any serious amount of cultivation. He then enters into a discussion of the bearing of rainfall-distribution upon time of sowing and other matters, into which, important though the matter is, it is not possible to follow him here. It is hoped later to publish papers dealing with this whole question. He gives tables of rainfalls for three years for Miombo and Mpanganya, pointing out that the latter has the more favourable distribution. The soil of the various districts mentioned he considers well suited to cotton, but he points out the dangers of flooding, which. for example, destroyed a great part of the 1912 crop upon the Rufiji.

He then goes on to explain that there are other suitable districts, as yet untouched, some of them needing irrigation, so that on the whole there is a prospect that the country might cultivate some 350,000 hectares (or 865,000 acres) in cotton, and produce some 260,000 bales at the current cropping capacity.

He then shows that, owing to the risks attaching to the present conditions, under which the water supply is neither controlled nor regulated, the cultivator who should devote himself to cotton alone would be taking too great a risk, and that he should also cultivate permanent crops like kapok or oil-palm, and food crops like rice or beans, or sugar-cane on the small scale.

The legislation enacted under German rule bearing upon cotton is then discussed, and the cotton experiment stations, agricultural schools, and such matters.

Considerable space is then devoted to a consideration of the results obtained with various cottons. The Upland types gave results considerably better than the Sea Island or Egyptian. The former, for example, averaged 116·3 kilos per hectare (103 pounds per acre) at Mpanganya in 1911, against 20·5 kilos for the two latter. In 1912 the results were 45·0 kilos against 29·4, and in 1913 11·6 against 9·3. The smaller result in the two latter years he puts down to late sowing on account of the floods. The staple averaged 28 to 30 mm. (25 go to an inch), and the quality was good. The greater value of the Sea Island and Egyptian was thus much outbalanced by the greater yield of the Upland, which was also more resistant to diseases and pests. The yield was found to be much increased by manuring or by proper cultivation, and a 12 per cent. increase was obtained by topping the plants.

Finally, the author gives a detailed account of the work that was done in the breeding of cottons suitable to the local conditions, a work that was interrupted by the outbreak of war. Without translating the whole article, it is not possible to give a fair account of this or of the methods employed. The Upland types were found the more promising for improvement.

Keeping the fields clean after taking the crop was found to be a difficulty, but was largely overcome by cultivating maize, beans, and manioc.

A PRELIMINARY NOTE ON A STERILE DWARF ROGUE IN SEA ISLAND COTTON

BY

L. H. BURD, B.A.

Cotton Research Worker, St. Vincent, W.I.

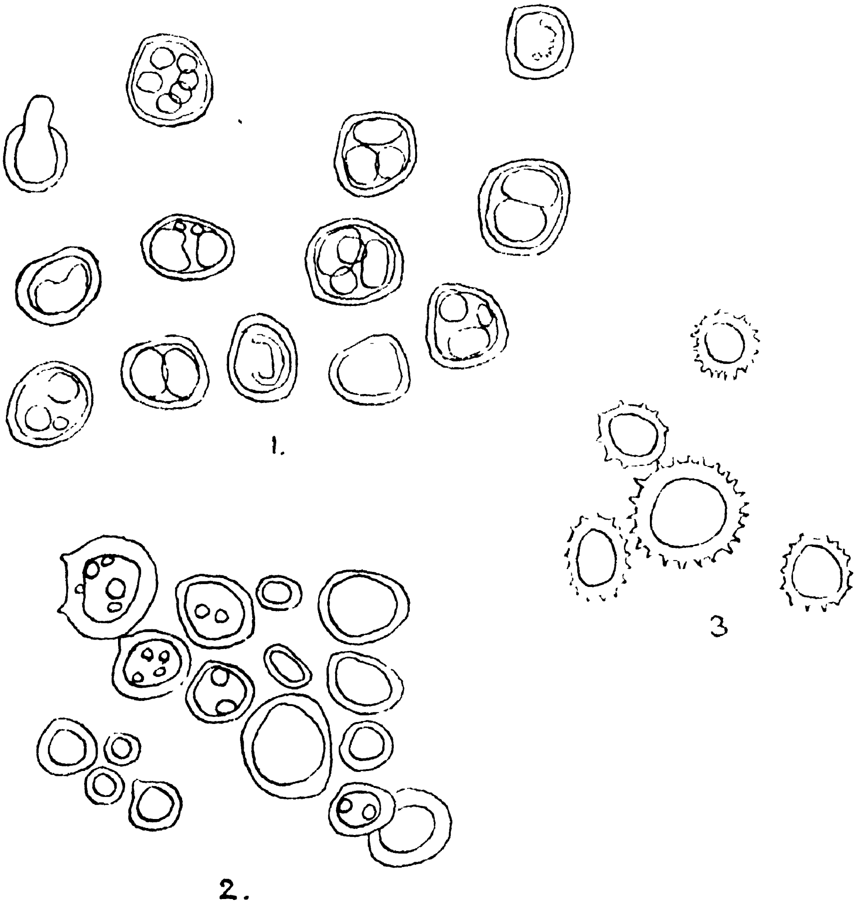
THIS rogue, which was noticed by the writer growing among the pure strain of Sea Island cotton (V. 135), is evidently not the same as that described by Harland in the *West Indian Bulletin.*[1] The plant was very much reduced in height and the size of the parts, but otherwise differed little from the normal Sea Island type. Almost all the leaves were three-lobed and very clearly and deeply cut, never showing a trace of the raggedness which he mentions. The bracts and flowers were small but typically Sea Island in their proportions. Further, the plant shed its bolls to an alarming degree and, probably on account of this, continued flowering very late into the season. Unfortunately, no record was taken of the amount of flowering and shedding. Normal dehiscence of the anthers did not seem to occur, and a brief examination showed that the pollen was abnormal. This led the writer to suspect that the shedding of bolls might be due solely to lack of fertilization (Mason),[2] and accordingly crosses were made between the rogue and the stock from which it arose, of course using the latter as pollen parent. Out of twenty such crosses, three bolls were retained, and each of these contained one seed. Twelve flowers were selfed, but all of those were shed. Finally, of all the flowers which remained (being neither selfed nor crossed), one boll was set, and it contained likewise one seed.

The occurrence of such a plant at once opens up a large field for cytological and genetical research, though the extreme degree of sterility renders the latter very difficult to carry out. The immediate problems are: the origin of the rogue and the nature and cause of the sterility.

The answer to the former can only be given after patient breeding. It would seem from the way in which the plant arose that it might well be a genuine mutation. The other alternatives are: slackness in handling the seed and self-sowing (which is unlikely, as a similar plant has not been seen before), or a lack of sufficient care in selfing the flowers last year, so that the plant may perhaps be an F.1 hybrid. In the latter case, it would most probably be a hybrid between Sea Island and a Serido cotton from Brazil, two or three plants of which are growing for experimental purposes in an obscure corner of the Experiment Station. The only other cottons in existence here are Sea Islands, and, so far as our present knowledge goes, these intercross freely without any sterility.

PLATE.

All figures drawn with the aid of a camera lucida.
Zeiss objective A 8 (10 × eye-piece).
Fig. 1: A group of abnormal "tetrads."
Fig. 2: Sterile pollen formed from the above (young).
Fig. 3: Sterile pollen formed from the above (mature).



The problem of the sterility (beyond saying that wide crosses are frequently sterile) lies in the domain of cytology. A preliminary examination of the pollen formation, using the aceto-carmine method, strongly indicates a disturbance of the chromosome mechanism

in the heterotype and homotype divisions. As the figures show, the tetrad formation is highly abnormal, any number up to seven cells being visible instead of the usual four. It was impossible, however, to examine these divisions critically this year, as until recently the necessary apparatus for handling paraffin sections had not arrived.

Should an aberrant chromosome number prove to exist, it remains yet to decide whether we are dealing with a mutational loss—it is difficult to see how an increase could arise—or whether with a case of incompatibility due to hybridization; and further, should it transpire that normal Sea Island and Serido cotton have the same number of chromosomes, and that our rogue has an aberrant number, then we have a very strong presumption that the latter arose as a mutation.

April, 1923

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[1] HARLAND, Dr. S. C.: " On the Genetics of Crinkled Dwarf Rogues in Sea Island Cotton," Parts I. and II., *West Indian Bulletin*, vol. xvi.

[2] MASON, T. G.: " Growth and Abscission in Sea Island Cotton." *Annals of Botany*, vol. xxxvi., No. cxliv.

COTTON GROWING STATISTICS—I.

COMPILED BY

JOHN A. TODD

THE aim of the following tables (which it is hoped to make a regular feature of the review in future) is to provide statistical data for (1) a survey of the world position with regard to cotton of all kinds, and (2) a more detailed examination of the progress of cotton growing in the Empire. In this issue all the tables have been carried back to 1902 (the date of commencement of the work of the British Cotton Growing Association), in order to provide an historical background, and for future reference. In future issues the tables will only deal with recent years, say from 1918, so as to allow of the necessary revisions which are constantly requiring to be made in such tables.

TABLE I. gives a summary of the whole of the world's crops. The chief difficulty in such an aggregate is the question of the varying bale weights in use throughout the world. In the present table the writer has used (*a*) for the American crop the Census Bureau figures, which are in bales of 500 lbs. gross or 478 lbs. net. These figures relate to the actual growth in each year, and may be contrasted with those of the *Financial Chronicle* (also used by the Liverpool Cotton Association), which are for the commercial crop.* Until 1914 there was never much difference between the two, but since then the difference has frequently been very marked, a large part of the cotton crops being held over in the interior in certain seasons.

(*b*) For the Egyptian crop the figures are founded on those of the Alexandria General Produce Association, which are in kantars of slightly less than 100 lbs. But in order to make a bale more nearly comparable with the American, these figures have been converted into nominal bales of 5 kantars, although, as a matter of fact, the actual Egyptian bale averages about 750 lbs. net. During the past three years the question of the up-country carry-over has complicated the question in Egypt also.

(*c*) For the Indian crop the figures are those of the Government crop forecasts, which are in 400-lb. bales. To add up figures based on these small bales with others of about 500 lbs. is obviously inaccurate;

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* In this case the "commercial" crop means the quantity which actually comes to market between the dates of the season (August 1 to July 31), as contrasted with the actual amount grown in any year.

but, as a matter of fact, until comparatively recent years the Indian figures seemed to be nearly always under-estimated to the extent on an average of just about 20 per cent.—*i.e.*, the difference between a 400-lb. bale and a 500-lb. bale. The writer therefore made it a practice to let the 400-lb. bales stand as a rough-and-ready method of overcoming this shortage. In recent years, however, the Indian figures have been much higher, especially as indicated by the test of the yield per acre, and there is some reason to believe that this is at least partly due to improved statistical methods which bring the Government returns much nearer to the actual figure. It must therefore be remembered in discussing the Indian figures that the bale weight is materially less than the American.

(*d*) For the Russian, Chinese and Smaller Crops (Table II.) the information available is extraordinarily unsatisfactory, the statistics varying enormously. Some are in running bales which may vary from 200 lbs. to 500 lbs., while others are an attempt to convert the figures into 500-lb. bales. But apart from this difficulty the statistics are in themselves entirely unreliable, the figures for a particular crop—*e.g.*, Chinese—varying in some years from estimates as low as 1,074,000 bales (commercial crop* only) to others as high as 5,300,000 bales (total production). Amid such statistical confusion the only method that can claim any authority is to put together all the various known estimates, and take the mean of the whole lot as an average. As a matter of fact, this method works out much better than might be expected, because one estimate that is known to be ridiculously small cancels out another which is known to be ridiculously high, and the final result is probably about as good a guess at the truth as can be made. It is by this method alone that the crop figures here given have been arrived at, and they are not put forward as founded on any actual knowledge of the facts, but simply as the best that can be arrived at, and probably not far from the truth on the whole.

Table III., Empire Cotton Crops. In this table a similar method has been adopted, and in the present issue it has been worked out in detail in one case, Nigeria, in order to show the method. The B.C.G.A. figures are quite frankly estimates or round figures, and do not pretend to represent the whole crop, because a great deal of cotton is grown in the country which never comes into commercial channels at all, but is entirely used for domestic consumption. The same is true of the export figures, but these do not necessarily relate to the same period or season as the actual crop growth. Again, the figures of the International Institute of Agriculture at Rome are apparently founded sometimes on the B.C.G.A. figures, and sometimes on the export figures, and have therefore no independent authority at all. Finally, the figures of the Department of Agriculture, which are likely to be the most correct, are at present very incomplete, but it is hoped in future issues to get them completed for recent years. It will then be possible to drop all the others, and give only the Department of Agriculture's figures. In the meantime the compilation of all four makes it possible to provide an historical record which is not likely to be far from the truth in many cases. A similar method has been adopted in all the other areas, but only the results are given—*i.e.*, the mean of all the figures.

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* Here "commercial" crop means only the quantity that comes into commercial channels—*i.e.*, mill consumption and exports, excluding domestic consumption for hand weaving, wadding of garments, etc.

Note.—For reasons of space, only the African table is given in this issue Others will follow later.

TABLE I.—THE WORLD'S COTTON CROPS, 1902-1923.

[*Bales of* 500 *lbs.* (*approx.*); 000'*s omitted. Linters included in American Crop.*]

	America.	*India.**	*Egypt.*	*Russia.*	*China.*	*Others.*	*Total.*	*Per Cent. on* 1914.
1902–03	10,784	3,367	1,168	342	1,200	801	17,662	63
1903–04	10,016	3,161	1,302	477	1,200	751	16,907	61
1904–05	13,697	3,791	1,263	536	756	803	20,846	75
1905–06	10,726	3,416	1,192	604	788	938	17,664	63
1906–07	13,305	4,934	1,390	759	806	1,027	22.221	80
1907–08	11,326	3,122	1,447	664	875	950	18,384	66
1908–09	13,432	3,692	1,150	698	1,933	971	21,876	78
1909–10	10,386	4,718	1,000	685	2,531	950	20,270	73
1910–11	11,966	3,889	1,515	895	3,467	968	22,700	81
1911–12	16,109	3,262	1.485	875	3,437	1,058	26,226	94
1912–13	14,091	4,421	1,507	870	2,360	1,160	24,409	88
1913–14	14,614	5,066	1,537	969	1,963	1,239	25,388	92
1914–15	16,738	5,209	1,298	1,152	2,332	1,146	27,875	**100**
1915–16	12,013	3,738	961	1,413	2,068	990	21,083	76
1916–17	12,664	4.489	1,022	1,085	1,569	1,039	21.868	78
1917–18	12,345	4,000	1,262	605	1,583	1,106	20,901	75
1918–19	12,817	3,972	964	334	1,725	1,312	21,124	76
1919–20	11,921	5,796	1,114	302	1,690	1,535	22,358	80
1920–21	13,711	3,600	1,206§	120	1,351	1,462	21,440	77
1921–22	8,378	4,479	972§	78	1,340	1,767	16,914	61
1922–23	10.438	5,196	1,243§	137	1,955	1,799	20,764	74
1923–24	*10,681*†	*5,000*†	*1,200*†	*150*†	*2,000*†	*1,850*†	*20,881*†	75

* 400-lb. bales. † 12 December estimate, *adding* 600,000 linters. ‡ Estimates.

		§ *Actual arrivals.*		(*Est.*) *Up-country Carry-over.*	(*Est.*) *Net Crop.*
1920–21	..	5,030,178	kantars.	1,000,000	6,030,178
1921–22	..	5,358,284	,,	500,000	4,858,284
1922–23	..	6,713,312	,,	—	6,213,312

TABLE II.—SUMMARY OF THE SMALLER COTTON CROPS, 1902–1922.

[*In* 500-*lb. bales* (*approx.*); 000'*s omitted.*]

Country.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	1911.	1912.
Persia	54	47	78	65	72	77	74	115	116	113	136
Europe and Asia Minor ..	88	90	102	113	131	141	134	133	157	174	176
Mexico..	117	124	164	185	209	110	181	162	157	158	172
Brazil	381	311	251	364	409	380	325	268	297	300	357
Peru	36	42	64	58	59	73	79	94	93	96	106
Other South American ..	4	6	5	5	8	11	12	11	11	19	13
West Indies (British) ..	1	1	2	3	3	5	6	5	4	6	5
West Indies (others) ..	6	7	8	10	9	11	12	10	10	12	13
East Indies, etc.	24	32	35	38	35	36	48	45	43	50	61
Japan and Korea	89	88	86	85	76	81	75	75	38	71	52
Africa (British)	1	3	6	9	12	19	19	23	31	44	53
Africa (others)			2	3	4	6	6	9	11	15	16
Totals	801	751	803	938	1,027	950	971	950	968	1,058	1,160

Country.	1913.	1914.	1915.	1916.	1917.	1918.	1919.	1920.	1921.	1922.	1923.
Persia	142	139	133	95	82	84	120	125	87	200*	—
Europe and Asia Minor ..	172	157	127	132	119	109	127	131	71	70*	—
Mexico	159	108	95	103	119	236	221	230	190	216	—
Brazil	399	387	298	351	419	497	553	427	659	700*	750*
Peru	134	122	116	129	125	138	187	159	181	175*	—
Other South American ..	14	14	14	16	20	22	24	42	74	70*	—
West Indies (British) ..	5	5	4	3	2	4	4	4	4	2	—
West Indies (others) ..	10	13	14	11	10	12	16	16	25	25*	—
East Indies, etc.	78	75	72	78	77	73	106	107	97	100*	—
Japan and Korea	59	68	63	63	79	91	116	133	130	132	150*
Africa (British)	51	55	52	55	51	41	56	77	123	76	134*
Africa (others)	16	3	2	3	3	5	4	10	25	30	—
Australia and Mesopotamia..	—	—	—	—	—	—	1	1	1	3	—
Totals	1,239	1,146	990	1,039	1,106	1,312	1,535	1,462	1,767	1,799	1850*

* Estimates.

TABLE III.—EMPIRE COTTON CROPS—NIGERIA

(In bales of 400 lbs.)

Seasons.	*B.C.G.A.*			*Exports.*			*All Nigeria.*					
	Lagos.	*Southren Nigerai.*	*Northern Nigeria.*	*Lagos.*	*Southern Nigeria.*	*Northern Nigeria.*	*B.C.G.A.*	*Exports.*	*I.I.A.* Original.*	*I.I.A.* Converted.*	*Dept. of Agric.*	*Mean.*
1902	—	—	—	31	—	—	—	31	—	—	—	31
1903	500	50	50	725	—	—	600	725	—	—	—	663
1904	2,000	100	100	2,157	714	718	2,200	3,589	—	—	—	2,895
1905	3,200	150	500	3,196	241	309	3,850	3,746	—	—	—	3,798
1906	6,000	150	1,000	6,740		890	7,150	7,630	—	—	—	7,390
1907	9,500	250	1,500	10,224		706	11,250	10,224	—	—	—	10,737
1908	5,500	200	500	5,736		500	6,200	5,736	—	—	—	5,968
1909	12,100	300	400	12,179		186	12,800	12,582	*Quintals.* **22,829**	12,582	—	12,691
1910	5,900	300	400	6,336		74	6,600	6,196	**11,241**	6,196	—	6,398
1911	5,800	300	600	5,085		168	6,700	5,595	**12,156**	6,700	—	6,148
1912	8,900	270	2,600	9,721		1,061	11,770	10,932	**21,355**	11,770	—	11,351
1913	14,200		2,000				16,200	15,903	**29,393**	16,200	—	16,052
1914	13,750		1,000				14,750	14,124	**26,762**	14,750	—	14,437
1915	6,300		1,200	Not given separately.			7,500	6,743	**13,608**	7,500	—	7,122
1916	9,400		10,800				20,200	18,635	**36,650**	20,200	—	19,418
1917	7,900		3,900				11,800	13,198	**21,410**	11,800	—	12,499
1918	3,100		3,000				6,100	3,700	**11,068**	6,100	—	4,900
1919	9,500		8,000				17,500	16,862	**31,751**	17,500	—	17,181
1920	10,700		5,500				16,200	18,241	**33,096**	18,241	—	17,221
1921	19,500		12,000				31,500	32,039	**58,131**	32,039	30,000	31,179
1922	4,600		9,000				13,600	16,504	**29,944**	16,504	14,796	14,966

Quintal = 100 kilos = 220·46 lbs. = 0·5512 bales of 400 lbs.

*** International Institute of Agriculture, Rome.**

TABLE IV.—EMPIRE COTTON CROPS—(A) AFRICA (EXCLUDING EGYPT).

MEANS OF THE B.C.G.A. ESTIMATES AND THE ACTUAL EXPORTS (WHERE BOTH ARE AVAILABLE), TOGETHER WITH THE ANNUAL REPORTS OF THE VARIOUS DEPARTMENTS OF AGRICULTURE, SO FAR AS OBTAINABLE.

(*In* 400-*lb. bales.*)

Year.	*Sudan.*	*Gambia.*	*Sierra Leone.*	*Gold Coast.*	*Nigeria.*	*Uganda.*	*Kenya (British East Africa).*	*Nyasaland.*	*Rhodesia.*	*Tanganyika.*	*Union of South Africa.*	*Grand Totals.*
1902	300	—	—	—	31	—	—	2	—	—	—	333
1903	2,000	27	27	38	663	—	—	142	—	—	—	2,897
1904	3,500	125	85	147	2,895	54	72	713	—	—	4	7,595
1905	4,000	153	186	137	3,798	240	249	1,942	—	—	24	10,729
1906	4,063	—	185	216	7,390	739*	228	1,757	100‡	—	50	14,728
1907	7,773	—	67	195	10,737	3,405*	202	1,655	200‡	—	54	24,288
1908	9,540	—	1	164	5,968	5,227*	464	1,845	300‡	—	106	23,615
1909	6,890	—	—	139	12,691	5,744	327	2,274	400‡	—	190	28,655
1910	15,185	—	—	65	6,398	12,924	404	3,671	400‡	—	109	39,156
1911	24,021	—	—	62	6,148	20,430	458	4,200	185	—	120	55,624
1912	18,411	—	—	76	11,351	27,647	819	7,447	307	—	80	66,138
1913	13,275	—	—	85	16,052	26,990	669	6,402	639	—	91	64,203
1914	9,521	—	—	79	14,437	37,009	272	6,621	568§	—	225	68,732
1915	23,920	—	—	65	7,122	25,751	283	7,663	316§	—	340	65,460
1916	16,361	—	—	73	19,418	23.446	187	8,656	212§	—	325	68,678
1917	23,431	—	—	107	12,499	25,339†	200‡	2,166	70§	—	249	64,061
1918	11,667	—	—	76	4,900	26,785†	200‡	6,677	18§	—	549	50,872
1919	12,634	—	—	—	17,181	36,519†	100‡	2,325	56§	—	1,528	70,343
1920	21,854	—	—	63	17,221	51,782†	100‡	2,284	35§	—	2,577	95,916
1921	27,684	—	—	48	31,179	81,150	500‡	3,688	100§	7,414	2,570	154,333
1922	24,252	—	—	15	14,966	40,000	400‡	5,569	126§	6,200	3,397	94,925
1923	*42,500*	—	—	—	*20,000*	94,014	—	*6,500*	—	—	*4,000*	*167,014*

(*The figures in italic type are estimates.*)

* In these years the Uganda exports included ginned and unginned cotton together.

† In these years the Kenya exports were included with Uganda, but the effect is negligible.

‡ B.C.G.A. figures only.

§ Exports from Northern Rhodesia only.

NOTES ON CURRENT LITERATURE

ABSTRACTS of current literature are already numerous, and it is not proposed to enter into serious competition with the established media of their publication. Those who desire to keep abreast of all current research will find the abstracts published by the British Cotton Industry Research Association, and those given in the *Journal of the Textile Institute* and the *Experiment Station Record* of the United States Department of Agriculture, simply indispensable. To compete with them would mean that we should require to organize a staff for the purpose, and the money can be spent to better advantage in other ways. All that is aimed at in this place is to give some kind of idea of what is going on in the elucidation of any question that is of interest to cotton growers, but the matter will be considered from a very broad point of view. As a rule, papers will be quoted by their full title; sometimes nothing more will be given, sometimes an abstract, original or copied from one of the publications above mentioned, with due acknowledgment for the use thus made of their material. So far as is reasonably practicable, an attempt will be made to give explanatory or illustrative notes in connection with the abstracts, and efforts will be made to obtain occasional reviews by competent authors of progress in various departments of work. Any suggestions for the improvement of this section of the journal will be welcomed.

It is proposed tentatively to enter the available material under the following principal headings:

Cotton in India.
Cotton in the Empire (other than India).
Cotton in the United States.
Cotton in Egypt.
Cotton in Foreign Countries.
Cultivation and Machinery, Irrigation, etc.
Diseases, Pests, and Injuries.
Breeding.
Legislation.
Chemistry and Physics in their Application to Cotton Problems.
Historical.
Miscellaneous.

COTTON IN INDIA.

"A PRELIMINARY STUDY OF THE DEMAND FOR VARIOUS TYPES OF INDIAN COTTON." (Bulletin No. 1. By B. C. Burt, B.Sc., M.B.E., I.A.S., Secretary Indian Central Cotton Committee.)

Although somewhat older in date than the early part of 1923, which is the general date we have taken for abstracting literature, this paper is too important to be passed by. We may quote the interesting introductory remarks, which lay emphasis on what is sometimes lost sight of, as well as the summary:

" Since the reorganization of the Indian Agricultural Departments in 1904, India has received a good deal of well-intentioned advice as to the improvement of her cotton crop, but unfortunately of a somewhat contradictory nature. Thus it has been variously urged that as a world shortage of cotton is approaching, the increase of quantity, irrespective of quality, is of primary importance; on the other hand, that an increase of 100,000 bales of good-stapled cotton is more important to the world than an increase of a million bales of short-staple cotton. Both these opinions are entitled to respect, as coming from organizations in touch with the world's markets, but are nevertheless disconcerting to those faced with the actual problems of cotton improvement. The Indian Cotton Committee, however, plainly stated that there is a genuine demand for Indian long-staple cotton, and in their report describe in considerable detail the steps which they consider will lead to progress in each cotton-growing province. A striking confirmation of the importance of staple occurs in a recent article by Dr. Todd* on the world's cotton crops of 1921, where, after examining in the light of all available statistics the supply and demand position, he makes the following statement:

" 'The bulk of the Indian crop is so short in staple that the actual amount of the crop really matters very little in the question of world statistics. That is specially true at the present juncture, because the American crop of 1921 contained, according to all reports, a larger percentage than usual of short and weak staple. Adding to this the fact that much of the huge carry-over at the end of last season was also of poor staple, it is apparent that any addition that the Indian crop might make to the world's supplies will be, on the whole, of the kind that is least wanted. The immediate shortage to-day is of good cotton of 1⅛ inches staple and over, and of that India produces none at all.'

" Since the contention has recently been revived 'that every extra bale of Indian cotton would release a bale of longer-stapled cotton,' it may, however, be pointed out that no evidence has ever been offered that the world's spinners can absorb any appreciably larger quantity of cotton of below ¾ inch to ⅞ inch in staple. On the contrary, such evidence as is available goes to show that in exceptional years of high production the carry-over of Indian short-staple cottons is heavy.

" Provincial Directors and Deputy Directors of Agriculture, and, indeed, all officers engaged on cotton research, are, however, faced with considerable difficulty in deciding the policy to be followed in cotton improvement *in respect to particular areas*. Admitting that India should grow more long-stapled cotton, is their area one where it will pay ? To what extent is improvement necessary ? Will a moderate increase in staple of the existing crop be permanently profitable, or should a clean cut be made and something much better aimed at ? Or, on the other hand, should a given area be definitely ruled to be a short-staple area where yield per acre and ginning percentage should be the primary consideration ? Will extra price for staple pay for decreased ginning percentage, or even for a lower yield ? These and similar questions and the ever-present question as to whether a profitable market can be organized for a new cotton confront every officer who has the responsibility of framing a cotton policy. And a definite policy is essential. To isolate, test, multiply and establish a new variety or strain of cotton is necessarily a matter of some years. Rarely is there any short cut to success. Whether the method adopted be the introduction of an acclimatized exotic, the production of a new variety by hybridization, or the selection of the best type from an existing mixture, much careful and laborious work is necessary. It cannot be scamped or hurried through, or an elaborate seed distribution scheme may break down at the last moment, when success is in sight, through intrinsic faults in the variety. This being so, it is essential that there should be continuity of policy, and agricultural officers should not be asked to give their time and energy to cotton improvement except in the carrying out of a definite policy, which must be far-sighted enough to enable the benefits of their work to be obtained before the next step forward is necessary. If it can be ascertained that a certain minimum degree of improvement is essential to permanent development, it is not economical to spend time and energy on less.

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* *Textile World*, February 4, 1922.

"The object of the present paper is to try and summarize such information as it has been possible to collect with regard to the trade demand for different cottons, and the trend of the changes which are believed to be taking place—not with the idea of suggesting a limited objective to research workers, but to indicate if possible where success may be looked for."

The author summarizes the position as follows:

1. India consumes normally in her own mills rather more than half of the average commercial crop.

2. An attempt has been made to group Indian cottons according to the counts which they are suitable for spinning. The difficulties in doing this have been explained, but the following tentative conclusions may be drawn:

3. Roughly 50 per cent. of Indian yarn production is of counts of 20s and over, and this proportion tends to increase. Production of this class of cotton is but little above actual mill requirements, leaving only a small exportable margin.

4. For yarns above 22s cotton production appears to be adequate to mill requirements, but the margin, though apparently adequate, is uncertain.

5. Indian production of yarn of counts above 32s is small, and shows no distinct tendency to increase. For the small quantity now produced cotton is imported to an appreciable extent. The absence of suitable local cotton may, therefore, be a limiting factor.

6. The exportable margin of Indian cotton is almost all of the shortest staple. There is a definite established export trade in the finer Indian cottons which seems to be limited by the supply, though partly by lack of cleanliness in Indian cottons.

7. It is obvious that it would be to the advantage of the Indian spinner and grower alike if the exportable surplus of Indian cotton contained a larger proportion of cotton suitable, at least, for spinning 20s. The grower would be producing a commodity more nearly equivalent to the general standard of the world's markets, and would run less risk of a discrimination against short-staple cotton in years of large crops.

8. The world's greatest shortage at present is stated to be of cotton of 1⅛ inches staple and upwards. The production of such cotton in suitable tracts would undoubtedly be a sound development. In the early stages the local demand from Indian mills would be a valuable asset, and the export demand appears to be assured.

9. To a certain extent, any advance in the quality of Indian cotton is an advantage. Even for low counts Indian mills now require better cotton than they used to use. But to ensure that premium to the grower which is so important in the introduction of a new crop it is necessary that a certain minimum degree of improvement should be effected. It is suggested that, except where conditions are unusually difficult, it would be wise not to be content with minor improvements, but to aim at producing cottons suitable for spinning 20s and over. In view of the general shortage of stapled cottons, it would be most unwise to introduce into any cotton-growing tract a cotton of lower staple than at present produced. [Table of Production on next page.]

NOTE.—The checking of adulteration, better ginning and cleaner picking, and better market organization all round, would appreciably increase this margin.

"PROGRESS OF COTTON GROWING IN INDIA." (By B. C. Burt, B.Sc., M.B.E., Secretary of the Indian Central Cotton Committee. Abstracted from the *International Cotton Bulletin*, No. 5, September, 1923, p. 99.)

The Secretary briefly indicates some further developments which have taken place relative to the work of the Indian Central Cotton Committee.

Two cotton measures have become law, viz.:

The Cotton Transport Act, 1923, making provision for (1) the restriction of

cotton transport in certain specified areas in order to prevent short-staple and inferior cotton being imported into superior cotton tracts for mixing purposes; (2) more definite regulation of transport by road, river or sea.

***The Cotton Cess Act*, permanently incorporating the Indian Central Cotton Committee, and enabling the Committee to take active measures for the furtherance of research.**

Much definite progress has also been made in most of the tracts in India growing staple cotton in maintaining and improving the type.

PRODUCTION OF INDIAN COTTON OF DIFFERENT DESCRIPTIONS.

[*In Thousands of Bales* (*Bale of* 400 *lbs. each*).]

Description of cotton.	1915–1916.	1916–1917.	1917–1918.	1918–1919.	1919–1920.	1920–1921.	*February Estimate, 1921–22.*	*April Estimate.*
OOMRAS.								
Khandesh	340	342	192	148	445	168	315	315
Central India ..	216	311	116	214	219	162	197	197
Barsi and Nagar ..	483*	537*	474*	647*	352†	162†	386†	386
Hyderabad Gaorani	—	—	—	—	335	122	420	420
Berar	830	691	428	498	931	288	813	813
Central Provinces ..	276		163	309	358	226	320	320
Total, Oomras ..	2,145	1,881	1,373	1,816	2,640	1,128	2,451	2,451
Dholleras	150	585	680	118	510	453	456	456
BENGAL-SIND.								
United Provinces ..	262	309	198	174	436	337	243	243
Rajputana	64	185	88	71	133	105	90	90
Sind-Punjab ..	247‡	419‡	365‡	614‡	777‡	635‡	349‡	349‡
Others	18	17	18	21	20	16	17	17
Total	591	930	669	880	1,366	1,093	699	699
Broach	230	304	314	169	308	199	170	170
Westerns and Northerns.	172	238	169	232	274	147	148	134
Cocanadas	35	48	29	51	36	42	46	42
Tinnevellys	84	134	99	344	234	242	253	254
Salems and Cambodia	32	47	217					
Coompta-Dharwars	231	260	356	252	296	216	187	187
Commillas, Burmas and other sorts. ..	68	75	94	116	132	81	70	70
Grand Total ..	3,738	4,502	4,000	3,978	5,796	3,601	4,480	4,463
Punjab American ..	10§	60§	58§	158§	141‖	144‖	101‖	101

* Includes Hyderabad.

† Includes the cotton grown in non-Government areas in Hyderabad.

‡ Includes Punjab-American cotton grown in the Punjab.

§ Approximate figures based on Report of the Department of Agriculture.

‖ Actual figures as stated in a letter of the Director of Agriculture, Punjab.

INDIA AND THE SUDAN as Sources for increasing our Raw Cotton Supplies. (Brit. Cotton Growing Assoc., No. 81, July, 1923, price 1s. By W. H. Himbury, General Manager.)

A most valuable report, which should be read in its entirety. The author believes (p. 13) that in five years India might produce two million bales of cotton suitable to Lancashire needs; and (p. 19) that cotton will play the major part in the future development of the Sudan.

"TECHNOLOGICAL RESEARCH ON COTTON IN INDIA." (Abstracted from the *Textile Recorder* of September 15, 1923, vol. xli., p. 57.)

In a statement recently issued to the Press, the Secretary of the Indian Central Cotton Committee announces that arrangements are well advanced for the establishment in India of a Technological Research Department for Cotton. Negotiations for a site near the Victoria Jubilee Technical Institute at King's Circle, Bombay, are practically complete; all the necessary machinery has been ordered, and orders for motors will be placed shortly.

The Laboratory will be equipped with a complete miniature spinning plant and will be under the control of an expert technologist. The work of the technologist will consist of carrying out laboratory tests on new cottons for the Agricultural Departments, securing authoritative valuations, arranging for and interpreting spinning trials, and carrying out general scientific work on Indian cotton fibres.

See also *Agricultural Journal of India*, July, 1923, p. 378.

COTTON IN THE EMPIRE (INCLUDING PROTECTORATES AND MANDATED TERRITORIES, BUT EXCLUDING INDIA).

CEYLON. *Cotton Experiments in Batticaloa, Ceylon.* (*Tropical Agriculturist*, September, 1923, p. 188.)

Experiments, usually with Cambodia cotton, and on very small areas, were tried in school gardens and other places. The average yield was at the rate of 195 lbs. per acre, but the plots were too small for this result to be of any value. The largest plot (0·88 acre) yielded at the rate of 127 lbs. per acre. Heavy rain at sowing time, boll worm, and leaf-roller were among the difficulties with which the cultivators had to contend.

CYPRUS. (Extracted from the *Annual Report of the Director of Agriculture*, 1922, pp. 9 and 17.)

The cotton crop has not made headway, as was hoped. New kinds of seeds have been tried by the Department with varied success, but so long as merchants make no distinction between varieties, and offer no inducement to growers to produce better crops, progress will be slow. The cotton grown for export—*i.e.*, irrigated cotton for long-staple—is necessarily limited to irrigable land. There is an extensive area suited to cotton growing if water can be found. Among the varieties introduced by the Department are Peterkin, Sea Island, Triumph, Allens, Sakellarides. A spinning factory at Famagusta does a good business and utilizes a good deal of the locally grown cotton.

COTTON YIELD AND AREA FOR THE WHOLE ISLAND.

Year.	*Acres.*	*lbs.* (*unginned*)		*Bales of* 400 *lbs.* (*ginned*)
1919	5,565	3,989,860	=	3,325 bales.
1920	6,162	3,224,270	=	2,687 "
1921	6,215	3,056,368	=	2,547 "

Iraq. (Extracted from the *Monthly Agricultural Bulletin of Iraq* for the period July 16, 1923, to August 15, 1923).

Harvesting of the cotton crop has commenced. Messrs. The British Cotton Growing Association are offering Rs. 425 per ton of good quality seed cotton as compared with Rs. 500 for the 1922 crop. In most cases where the crop has been properly watered the quality of the cotton is good. In the Yusufiyah, Fellujah and Baghdad riverain areas the seed distributed was of superior quality to that distributed to other tracts. In the 1924 season there will be ample seed of this improved strain of *Mesowhite* to meet all demands. Numerous complaints have been received regarding the severity of the bollworm pest of the cotton plant. On investigation it is found that the apparent incidence of the pest is greater where the plants have suffered from water shortage or from indifferent cultivation.

(Extracted from the *Monthly Agricultural Bulletin of Iraq* for the period August 16, to September 15, 1923).

The delivery of cotton at the British Cotton Growing Association Ginnery, Baghdad, indicates a distinct advance in cotton cultivation. The total deliveries up to the end of the period under review were 221 tons. At least 1,000 bales (of 400 lbs.) of raw cotton are estimated for current season. The bollworm attack is about normal, except in those cases where the crop has received an insufficient supply of water during July and August. In the latter case the bollworm destroys the majority of the young buds and flowers which appear in very large numbers with the advent of cooler weather. Very heavy late pickings are anticipated. Cotton-buying agencies have been arranged at Baghdad, Hillah and the Dialah Area. Many cultivators are holding their stocks of seed cotton in anticipation of a rise in price from the Rs. 425 per ton now offered. Special interest attaches to the enquiries which are being received regarding the purchase and erection of pumping plant with which to cultivate cotton.

NORTHERN TERRITORY (Australia). *Report on the Cotton-Growing Possibilities in the Northern Territory.* By G. Evans, C.I.E., Director of Cotton Culture in Queensland.

QUEENSLAND. And *cf.* under Legislation, p. 75. (Extracted from the *Queensland Agricultural Journal*, September, 1913, vol. xx., part 3, p. 270.)

Seed Cotton Deliveries.—The British Australasian Cotton Growing Association, Ltd., advises that the receipt of seed cotton at the various ginneries to August 14 was as follows:

	lbs.	£	s.	d.
Rockhampton	3,630,725	79,271	4	8
Wowan	1,757,941	40,275	7	8
Whinstanes	4,503,171	102,381	5	10
Gayndah	711,816	16,311	9	8
Dalby	402,161	9,215	12	1
	11,005,814	247,455	19	11

The Government and Cotton Growing Association—Terms of Agreement—Ginning and Marketing. (Extracted from the *Queensland Agricultural Journal* for September, 1923, vol. xx., part 3, p. 268.)

The Minister for Agriculture (Hon. W. N. Gillies) has laid upon the table of the Legislative Assembly the papers appertaining to, and copies of, all agreements entered into by the Government with the British-Australian Cotton Growing Association in respect to the ginning and marketing of seed cotton grown in Queensland.

Terms of Agreement.—A copy of an agreement dated September 30, 1922, sets out that the Company should, before July 31, 1924, erect, equip, and complete in Queensland so many cotton-ginning factories as might from time to time during the period of the agreement be sufficient for treating all the seed cotton grown in Queensland during such period, and at least one cotton-seed oil mill for the treatment of surplus cotton seed. Every factory erected by the Company should, unless otherwise approved by the Minister, continue proper railway facilities connected with the Queensland Government railways.

The Company undertook to expend at least £150,000 in the erection, equipment, and completion, before July 31, 1924, of ginning factories and oil mills in Queensland.

The Government should pay the Company 1½d. per lb. for lint ginned, pressed, baled, and delivered on trucks for shipping. All cotton seed, other than the seed required by the Government for cotton growers for planting and for planting Government experimental plots, and all linters and by-products, should be the property of the Company, but the Company should pay to the Government such price as may be mutually agreed upon.

The Company, at the request of the Minister, should consign, free of cost on railway trucks at the factory to cotton growers for planting and for planting on Government experimental plots, such cotton seed of best quality as might be necessary. Such cotton seed should be delivered, properly bagged or baled, at such times and in such quantities as the Minister should require; and the Company should charge ½d. per lb. for seed so delivered to cotton growers as its agents, and should demand and receive the payment therefor on behalf of the Government.

The Company should have the right to refuse to accept delivery of or issue a certificate for any cotton which is diseased, stained, or immature, or is not of good quality; but shall notify the Minister and the consignor that such cotton is diseased or not of good quality, and the Minister should determine whether it should be accepted, and, if so, at what rate and upon what terms.

The Government appoints the Company the sole agent of the Government for the shipping and sale of the lint produced from seed cotton. The Company, if required by the Government, should sell any portion of lint in Australia that the Government desired.

The Company is to act as agent for the Government in connection with the carrying out of the existing agreement between the Government and the British Cotton Growing Association. All lint not of quality for acceptance by the said Association shall be sold by the Company at the best price procurable.

The Company may allow not more than two months' credit to any customer, but may not, without the consent of the Minister, allow any longer credit.

The Company shall be entitled to a commission at the rate of 1¼ per cent. on all lint delivered by the Company to the British Cotton Growing Association or any person or Corporation, and a commission at the rate of 2½ per cent. on all lint sold by the Company, including lint sold by the Company after rejection by the British Cotton Growing Association, but no commission is to be paid if the Company, either directly or indirectly, becomes the purchaser of, or is in any way interested in, the purchase of any lint, the subject-matter of the agreement.

The Company at all times must permit the Auditor-General of Queensland, or authorized person, to examine and audit all books and accounts of the Company relating to the agreement. The agreement is to take effect from August 1, 1923.

An addendum states that the agreement is extended for a period of two years from July 31, 1924, upon the same terms and conditions.

Sierra Leone. *Cotton Growing in Sierra Leone.* (From the *Sierra Leone Royal Gazette*, No. 2,116, 1923.)

Contains a report by the Imperial Institute on three samples of native cottons. Quande was valued in Liverpool at 14.50d. to 14.75d., and Fande-wa at 14.00d. to 14.50d., with middling American at 15.06d. per lb. The third kind, Ndului, was valued at 8.00d.

An ABC on Cotton Cultivation in Sierra Leone (issued by the Division of Agriculture, Lands and Forests Department, Freetown, 1923). A useful guide for local beginners.

Sudan. *Cf.* abstract on p. 59, above (India and the Sudan).

Sudan.

October 21, 1923.

The Sudan Cotton Crop for the present season is estimated by Mr. W. A Davie, in a letter to Mr. Himbury under the above date.

Sakel.

	Kantars.	
At Wad el Nau	80,000	
,, Tokar	50,000	
,, Kassala	15,000	
,, Shambat and Kamlin	1,500	
,, Private estates	3,000	
Total ..	149,500	(or about 35,000 bales).

American.

At Zeidab	9,000	
,, Berber and Dongola	13,000	
,, Sakia cultivators in Berber and Dongola	1,500	
,, Blue Nile and Fung Provinces	6,000	
Total ..	29,500	(or about 7,500 bales).
		42,500 ,,

COTTON IN THE UNITED STATES.

"The Price of American Cotton under the New Conditions of Production." (By Arthur Richmond Marsh, Editor of the *Economic World*, New York. Abstracted from the *International Cotton Bulletin*, No. 5, September, 1923, p. 90.)

The conditions of cotton production in America have fundamentally changed within the past three or four years. Two economic factors are powerfully affecting the average cost of producing cotton, viz.:

(1) The occupation by the boll weevil of practically the entire cotton producing area, and a resultant decrease of some 30 per cent. in the average yield of cotton per acre.

(2) The diminution in the number of cotton farmers, owing to the knowledge being forced upon them that industrial and urban occupations are far more remunerative and dependable than cotton growing under the prevailing conditions.

Another factor affecting the cost of production is the great change in the general level of prices paid for commodities and for labour, which is 100 per cent. higher than in the pre-war years.

[The important question—What fall in price (of raw cotton) would cause the abandonment of considerable areas now in cotton?—is thus seen to be one that may at any time come into prominence. Nothing could be a greater stimulant to cotton cultivation than the present high and increasing prices.]

Cf. also abstract on p. 72, "Getting along with the Boll Weevil"; and on p. 78, *The International Cotton Bulletin.*

COTTON IN EGYPT.

THE BASIS OF EGYPTIAN AGRICULTURE AND ITS RELATION TO THE DECLINE IN THE AVERAGE YIELD PER FEDDAN OF COTTON. By E. McKenzie Taylor and A. Chamley Burns. Bulletin No. 25 issued by the Technical and Scientific Service of the Ministry of Agriculture, Egypt. (See *Agricultural Journal of India,* September, 1923, vol. xviii., part v., pp. 525-526.)

In this paper the authors attribute the decline in the yield of Egyptian cotton to the effect of the conversion of Egypt from the older "basin" system, which allowed of a period through May, June, and July during which the land received no water, to the present system of perennial irrigation. Experimental and statistical evidence is produced in support of this contention.

The authors also suggest ploughing during the summer period as a means of suppressing protozoa in the soil and restoring it to its crop-producing power.

The paper is illustrated by charts relating to the yield of cotton, and is furnished with an appendix describing a new method for determining ammonia in soils.

COTTON IN FOREIGN COUNTRIES.

COTTON GROWING IN BRAZIL. (Extracted from the *Agricultural Journal of India,* July, 1923, vol. xviii., part iv., p. 426.)

"Attention was drawn in a recent issue of this journal to the exhaustive report issued by Mr. Pearse, Secretary, International Federation of Master Cotton Spinners' and Manufacturers' Associations, on the prospects of Brazil becoming one of the great cotton-producing countries of the world. Mr. Pearse shows that not only does Brazil already produce large quantities of excellent cotton which, if properly handled, would be a valuable addition to the world's supply, but that the yields obtained are extremely high, and that the prospects of further expansion are most favourable.

"An International Cotton Conference was organized at Rio de Janeiro by the Sociedade Nacional de Agricultura in October, 1922, which was well attended. The full report is not yet available, but the resolutions passed have been published, and those which appear to be of general interest are given below."

[The resolutions give so useful a summary of the various points that must be kept in mind in beginning cotton cultivation, that it seems advisable to give them in some detail, shortening where necessary, the Corporation, of course, taking no responsibility for the correctness of recommendations or other points.—ED.]

INTERNATIONAL COTTON CONFERENCE

The Conference was held under the auspices of the Government of the Brazilian Republic, in Rio de Janeiro, from 15th to 20th October, 1922. It was organized by the Sociedade Nacional de Agricultura, Rua 1° de Março, Rio de Janeiro, under the presidency of Dr. Miguel Calmon du Pin e Almeida, now Minister of Agriculture.

Resolutions of the Rio International Cotton Conference.

First Section: *Cotton in Brazil—General enquiry into the cultivation of cotton in the various States of Brazil and abroad—Improvement of cotton growing in Brazil.*

1. **World's Cotton Situation and Brazil in Particular.**—This International Cotton Conference, representing twenty nations, after due consideration of the world's shortage of cotton, which has a tendency to continue or to become more pronounced, expresses the unanimous opinion that all those countries in the world which possess the essential conditions for cotton growing, should employ all the means in their power to initiate and develop cotton cultivation. This Congress is convinced of the extremely remunerative prospects awaiting cotton cultivation under rational conditions.

This Congress expresses the opinion that Brazil, which already supplies all the cotton requirements for its internal consumption, should prepare to take her place in the large markets of the world, by becoming one of the constant and regular suppliers of cotton.

2. **Study of Cotton Growing.**—. . . Recommends that greater attention be given to the teaching of cotton growing in agricultural schools and other establishments of elementary, intermediate, and higher education, as upon the instruction of the masses depends largely the improvement and development of cotton growing.

3. **Experimental and Demonstration Establishments.**—. . . Recommends the organization of official stations for experimental, co-operative, and demonstration purposes, with the object of improving the cotton and the method of its cultivation, bearing especially in mind the study of local varieties already existing in Brazil.

4. **Production of Selected Seed.**—. . . Considers the establishment of farms for the production of selected seeds of fundamental importance. In every State there should be one such seed farm for each of the various cotton zones.

(*a*) Such farms, which should become self-supporting, are to be managed in such a way that the relative profit resulting from the cultivation of any variety can easily be determined.

(*b*) The seeds from such farms are to be sold at the current market price to those farmers who undertake to plant no other cotton seed on their lands.

5. **Cultivation of American Cotton.**—. . . Recommends, in view of the fact that American cotton, $1\frac{1}{8}$ to $1\frac{3}{16}$ of an inch (28 to 30 mm.) in length, is most in demand in the cotton markets of the world, that this kind of cotton should be increasingly grown, without interfering, however, with the cultivation of longer staple cotton in those parts of Brazil which possess the necessary climatic and soil conditions.

6. **Mechanical Cultivation.**—The use of modern agricultural implements is recommended, and each State should ascertain, by experiment, which implements are most suited for its conditions.

Facilities for the purchase of agricultural implements of the above type should be granted by State and Federal Governments.

7. **Fertilizers.**—The agricultural establishments of the State and Federal Governments are recommended to determine by experiment which fertilizers are best adapted to their respective districts.

The Governments should control the trade in fertilizers by special laws as regards their origin, composition, and comparative agricultural value.

Facilities for the purchase of fertilizers should be granted by the State and Federal Governments.

8. **Picking of Cotton.**—This Congress is of opinion that generally cotton picking and warehousing in Brazil are performed in a most careless manner, which accounts for the fact that Brazilian cottons are not able to command in the world's markets the best prices.

Means should be taken that the grower of clean picked and well-stored cotton receives its commensurate value.

9. **Cotton and the Immigrant.**— . . . An increase in the cultivation of cotton would be a means of stimulating the influx of immigrants, as cotton is a quickly growing crop which can be readily realized within a very short time after arrival of the immigrant on his plot of land.

10. **Extension of Measures to Countries Abroad.**—To foreign countries which possess the same or similar conditions as Brazil, it is recommended that the measures suggested in these resolutions be also adopted by them.

SECOND SECTION: *Cotton diseases and pests—Defence service.*

11. **International Action against Harmful Insects.**—That harmful insects, such as the ringworm (*Gasterocercodes gossypii*), the pink bollworm (*Gelechia gossypiella*), and the cotton worm (*Alabama argillacea*), cause considerable damage to the cultivation of cotton, and require, therefore, intensive propaganda work of the methods known for their extermination. These pests should be combated with special care by the authorities of Brazil and all cotton growing countries. All the most practical methods should be immediately applied for this purpose. . . .

13. **Early Cotton Varieties.**—That, as a means of defence against insects in general, preference should be given to early maturing cotton varieties, and these should be planted in accordance with the local meteorological conditions.

14. **Means to be taken for combating the Pink Bollworm.**—In combating the pink bollworm in particular, and in a general way all insects harmful to cotton in Brazil, the following measures are recommended:

(*a*) Each farmer should arrange his new fields in such a way that they are at least two kilometres apart from the old ones or where cotton was formerly cultivated.

(*b*) All the vegetable growth of old cotton fields should be burned. Such land should be used for other crops or pasture, and cotton should not again be planted in the same field except after a lapse of a minimum period of three years.

(*c*) The cotton pickers should carry with them during the picking process two receptacles, one for sound cotton and the other for infected bolls; these latter should be burnt at the side of the field.

(*d*) The farmer should immerse the seed for two minutes into hot water; the temperature to be not less than 55° C. and not more than 60° C.* This is recommended as a sure remedy for the destruction of the insects.

(*e*) Annual varieties should be planted in districts suitable for their cultivation; all the plants, stalks, etc., should be torn out after picking, and they should be burnt at the side of the field in order to destroy all possible sources of infection.

(*f*) In case of perennial cottons, after severely pruning the stem, the branches and remnants which have thus been cut off should be burnt to ashes.

15. **Certificate of Seed Disinfection.**—The establishment of the necessary installation to enable the strict compliance with the requirements of a certificate of seed disinfection, so that in case of need the transportation of seed through the country by any means of communication without this certificate be forbidden, whatever be the destination of the seed.

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* This will require considerable care: a temperature below 55° C. will be of no practical use, and one above 60° C. will be dangerous to the seed.—ED.

16. **Steps to be taken, Regulations and Laws.**—. . . Rigorous compliance with the rules and regulations, framed. . . .

17. **Quarantine.**—The detailed study of the methods of disinfecting the soil by the quarantine system in those districts of Brazil where it is feasible, as satisfactory results have been obtained by it in the United States of North America.

18. **Educational Campaign.**—The intensification of propaganda work through objective instruction to farmers, together with the direct method specified in the previous resolutions of this Section, especially as regards the pruning of the tree cottons, showing how all the remnants must be burnt at the edge of the fields.

19. **Disinfection of Seed Cotton.**—The study of the most practical, efficacious, and economical means of disinfecting cotton carried in the state of seed cotton. . . .

20. **Disinfecting Plants near Gins.**—The intensification of propaganda work for the installation of disinfecting plants throughout the country, close to each ginning factory; in such places seed cotton and seed awaiting disinfection should be stored in warehouses covered in by wire netting.

21. **Co-operative Action for Disinfection and Storage.**—Co-operative societies should be formed amongst the small farmers and ginners of cotton with the object of getting the seed disinfected as soon as possible and the seed cotton properly stored; seed awaiting disinfection should be stored in warehouses whose openings are well protected by wire netting.

22. **Cotton Defence.**—A perfect understanding be arrived at between the public authorities . . . and . . . individuals in the strict observance of the steps for the defence of cotton suggested . . . .

23. **Study of Early Maturing Varieties.**—The study on the official experimental stations of early maturing varieties as a means of overcoming the pink bollworm, other insect pests and cotton diseases.

24. **Forest Plants.**—The study of forest plants on which the pink bollworm might hibernate. . . .

26. **Brazilian Conference upon combating the Pink Bollworm.**—That every year . . . a national Pink Bollworm Conference be held for the purpose of studying all the questions relating to this pest, and surveying the progress of the work, with a view to achieving the complete extermination of this pest.

27. **Sanitary Certificates.**—That they insist upon the introduction of sanitary certificates of international validity for all vegetable matter. Such certificates are to be signed by the official of agricultural defence organization.

28. **Restriction of Import and Export.**—That the restriction of imports and exports provided for by the laws of the various countries be enforced.

29. **Legislative Measures.**—That legislative measures capable of execution be adopted in order to provide for the compliance with the suggestions made by this Conference.

30. **Prevention of the two most dreaded Plagues.**—That efforts be made to protect against the entrance in their territory of the two worst plagues, viz., the Pink Bollworm (*Lagarta rosada*) and the Boll Weevil (*Gorgulho da Maca*) by limiting the importation of cotton products to certain defined ports, at which apparatus for the efficient disinfection of such raw materials should be installed.

31. **International Congress for the combating of Cotton Insects.**—That the representative of Brazil at the International Institute of Agriculture at Rome suggest that this Institute call together an International Congress for the combating of cotton diseases and pests, with the object of establishing legislation on an international basis.

THIRD SECTION: *Cotton of the North-East of Brazil—Ginning of cotton—By-products of cotton.*

32. **Establishment of Experimental Station in Seridó.**—. . . To enable the fixing and preserving pure, through selection, of the best type of long-staple cotton.

33. **Assistance to Rural Workers.**—In order to increase and improve the cotton in the north-eastern parts of Brazil, it is essential that the rural worker be efficiently assisted, especially in the interior, by means of the construction of reservoirs, cheap transport facilities, agricultural credits, and instruction.

34. **Increase of Cultivable Area.**—The area cultivated with cotton in the north-east should be increased, by making use of the irrigable "taboleiros" (highlands). The Government should demonstrate the advantage of irrigation by means of pumps and canals. . . .

35. **Use of Irrigable Land.**—The owners of land irrigable by means of the large reservoirs should cultivate their land within two years from the construction of the reservoirs; in case they do not comply, the land should be disappropriated. The charges for irrigation should be moderate, to enable the cultivation and the rapid use of land fertilized by the large deposits of water.

36. **Foreign Capital.**—In view of the great importance to the country, it is desirable that foreign capital should co-operate in the development of irrigable land. The concessions for such undertakings should, however, be made with due care, in order not to allow a monopoly to the detriment of the development of the cultivation; such concessions must also be made in such a way as cannot exercise a pressure on the rural population. . . .

40. **Permanent Cotton Committee.**—In each Cotton State a permanent Cotton Committee be appointed, composed of an Executive Council, constituted by the highest officials of the Federal Cotton Service, also of six members elected from the Commerce, Industry and Cultivators of Cotton, and of as many members of commissions as correspond to the municipalities existing in each State interested in cotton.

(*a*) The Governments should recognize these committees as a consulting body for the study of all cotton questions.

(*b*) These committees should combine in a federation, which should be represented in the National Agricultural Society for the defence of all cotton interests in accordance with its decisions. . . .

42. **Dissemination of Practical Instruction.**—. . . Establishment of elementary technical schools for the purpose of educating young men to enable them to become farm managers. . . .

(*a*) Such schools will be established in the proper cotton zones, on the lines of a model farm, essentially of a practical nature; . . . at least every 100 kilometres such a school should be started, and each school should maintain ten students free of charge.

(*b*) The right to a free studentship (with board) will be decided by special judges, composed of technical experts of the Cotton Service, etc. . . .

45. **Seed Disinfection.**—(Prizes to be offered for the best methods suggested.)

46. **Care in Picking.**—All means should be used to have cotton properly picked, that not only should the various types be kept apart, but also all the usual adhering remnants of foreign matter should be eliminated.

47. **Saw and Roller Gins.**—Under the present conditions of mixture of various cottons the use of saw-gins is advisable; it is, however, necessary to attend to the saws properly and regularly and the speed of the machines should be watched, in order to avoid damage to the fibre. It is indispensable that all gins be provided with feeders, cleaners, and condensers. These requirements should be

superintended by officials of the Cotton Service, or others specially appointed for this purpose, who will not only inspect the machinery, but also undertake the careful sharpening of the saws, free of charge.

The ideal treatment of long-staple cotton is by means of roller gins, and the Government should foster by all means at its disposal the introduction of such roller gins. . . .

48. **Fraudulent Packing.**—Frauds committed in the packing of cotton, such as adding linters, foreign substances, seed, etc., should be strictly punished. . . .

49. **Disinfection of Cotton Seed for Oil Mills.**—Cotton seed should be disinfected, and seed warehouses should be duly planned in such a way as to be dry and be protected by means of wire netting, so as to prevent the escape and propagation of the pink bollworm. . . .

51. **Refining of Cotton-seed Oil.**—The refining of oil by means of sulphuric acid should be effectively prohibited, if the oil is to serve as a food.

FOURTH SECTION : *Intensification of cotton cultivation—The Federal Cotton Service.*

53*a*. **Planting of Selected Seed.**—In the whole country the planting of selected and disinfected seed should be undertaken.

53*b*. **Different Varieties in the Same Field.**—It should be strictly prohibited to plant seeds of different kinds of cotton in the same field, after it has been ascertained which kind is best suited to a district. . . .

57. **Cotton Ordinances.**—All cotton-producing States which have so far not yet adopted protective regulations for cotton are requested to do so. . . .

58. **Frauds in the Ginning and Registration of Marks.**— . . . A special ordinance should be issued, so that the mixing of inferior types with long-staple cotton be forbidden . . . that in each ginning factory the bales be marked by means of marks, registered in the . . . agency of the Federal Cotton Service.

59. **Supervision of Ginning Factories.**—The supervision of the installation and working of the gins, in order to avoid the irregularity in the speed of the gins to the detriment of the fibre and to demonstrate the necessity for frequently sharpening the saws.

60. **Collection of Statistics.**—Each ginning factory shall keep a book, in which all the lots ginned are registered, with a view to enabling the building up of statistics on the model of the Bureau of the Census, Washington, D.C., U.S.A. . . .

65. **Use of Hulls.**—The greatest possible use should be made of the hulls either as a manure or as fuel, or further, as a raw material in the preparation of cellulose, which can be employed in the making of paper.

66. **Use of Cotton-Seed Cakes.**—The greatest use of cotton-seed cakes either as a cattle fodder or as manure in view of its great feeding and fertilizing value. The Federal and State Agricultural Services are to make all energetic propaganda in favour of this throughout Brazil.

67. **Exportation of Cotton Seed and Cotton-Seed Cakes.**—With a view to rendering the export of cotton seed and of cotton-seed cakes difficult, suitable export taxes should be established.

FIFTH SECTION : *Classification of cotton and establishment of commercial types of cotton and of the by-products of cotton—Cotton trade in general.*

68. **Classification of Cotton.**—All Brazilian cottons shall be graded in types corresponding to those of Liverpool, viz.:

Good ordinary American (" Soffrivel ").
Low Middling (" Commum ").
Middling (" Bom ").
Good Middling (" Superior ").
Fully good middling (" Excellente ").

69. **Seed Selection.**—Seed selection should be carefully undertaken, and certain cotton districts should only plant special seeds with a view to avoiding, in this way, a mixture of the different varieties. As long as cotton is not of a uniform quality, the consumer can only pay the price corresponding to the lowest quality in the sample.

The characteristics of cotton which enable the consumer to obtain the best results may be enumerated as follows:

(*a*) Fibres equal in length.
(*b*) Ripe cotton.
(*c*) Grade (colour, absence of leaves and foreign substances) uniform throughout the lot.
(*d*) Absence of dead cotton, seed and foreign matter. . . .

SIXTH SECTION: *Spinning and weaving mills and the consumption of cotton in Brazil—Exports of cotton goods from Brazil.*

78. **Insufficient Production of Cotton in the World.**—. . . Advise Brazil to undertake . . . prudent and progressive preparatory measures, . . . as although to-day the insufficient supply of cotton is not yet felt, the shortage of production will be felt as soon as the world's buyers of cotton goods, the great consuming countries of Central Europe, the Balkans and Russia, are able to re-enter the markets. . . .

SEVENTH SECTION: *Economical cotton protection—Exportation of cotton and cotton by-products.*

84. **Economical Cotton Protection.**—. . . The adoption of an organization similar to that which, under the name "National Bank for the Exportation of Sugar," was established last December for the sugar industry. . . .

85. **Centres of Brazilian Cotton.**—The creation of permanent centres for cotton of Brazilian origin in the markets of Europe.

THE BRAZILIAN COTTON CROP.—The British Commercial Secretary at Rio de Janeiro, Mr. E. Hambloch, reports that according to information published by the Cotton Service of the Ministry of Agriculture, the cotton crop for the year 1922-23 is calculated at 119,870,000 kilos, from 611,948 hectares, or roughly 264 million lbs. (528,000 bales of 500 lbs.) from 1½ million acres, a yield of 175 lbs. to the acre. Nearly half the exported cotton in the first nine months of 1922 came to Great Britain, the next best customer being Portugal, then France, Germany, and the United States in order.

SYRIA. (Extract from the *Journée Industrielle*, August 26/27, 1923.)

An article under the title "La culture du coton en Syrie pourrait être avantageusement developpée," says that satisfactory results have been obtained in the State of Alaoites, where Egyptian cotton in 1922 yielded at the rate of 394 lbs. per acre for Mit Afifi and 324 lbs. per acre for Fathi. If further experience shows that this result can be regularly repeated, there are large areas available, and irrigation and labour, according to the writer, are fairly satisfactory.

CULTIVATION AND MACHINERY; IRRIGATION, ETC.

"GERMINATION OF COTTON SEED." (By M. E. Sherwin, *Journal Amer. Soc. Agronomy*, 1923, vol. xv., pp. 66-73. Extracted from the *Agricultural Journal of India*, September, 1923, vol. xviii., part 5, p. 554.)

"The results of experiments on germinating cotton seeds in different types of soil, either with the seeds in direct contact with various fertilizers or with the fertilizers mixed with the soil in which the seeds are planted, indicate that germination is generally inhibited by the presence of fertilizers. This inhibition is greater when the fertilizer is in direct contact with the seed, and is generally proportional to the amount of fertilizer used; it is greater with the more soluble mineral fertilizers. The inhibiting action is apparently due to a retarding influence upon the osmotic absorption of water from the soil by the seed in the case of the soluble mineral fertilizers, or to the stimulation of the growth of fungi which are injurious to the root systems of the young seedlings, in the case of organic fertilizers such as cotton-seed meal. Borax in small amounts exerts a marked inhibiting effect upon root growth which is not counteracted by the addition of ferrous sulphate in solution."

"MARKETING OF RATOON COTTON." (Extracted from the *Queensland Agricultural Journal*, August, 1923, vol. xx., part 2, p. 112.)

In view of the temptation to ratoon cotton that is often present to growers, the following extract is of interest:

"Replying to a question in Parliament on the subject of the disposal of ratoon cotton, the Minister for Agriculture and Stock (Hon. W. N. Gillies) stated that the Agent-General, who is quite alive to the position, and after making discreet enquiries amongst English spinners, had cabled that ratoon cotton is not wanted. Enquiries already made indicated that the average market price for such cotton would only ensure the Queensland grower from 2d. to 2½d. per lb. in the seed. Our experts advise that our only hope of permanently establishing an industry that will stand on its own feet is to produce a high standard of annual cotton."

"BENNETT COTTON HARVESTER." (By W. Whittam, *Textile Recorder*, 1923, vol. xl., No. 480, pp. 77-81. Extracted from the *Agricultural Journal of India*, vol. xviii., part 5, p. 553.)

"The operations of picking, cleaning, ginning, and baling are combined in this machine. The parts of the machine are mounted on a steel frame carried on caterpillar tractors, and the power unit consists of a 60 horse-power petrol engine. The machine is provided with 10 lines of vacuum picker hose, and the cotton bolls are discharged thence into a cleaning box, which, in turn, delivers to the gin. The lint cotton then passes to a condenser which deposits the cotton in layers in the baling press. The seed is collected in a separate receptacle. In field operation the harvester straddles one row of cotton; the plants in this row and the two adjacent rows are protected by fenders. The machine moves at a speed regulated according to the relative number of open bolls. Two outstanding advantages of the machine are: (1) The gins can be kept in perfect order, and as there is no need to run them at very high speeds there is very little fibre damage; (2) the gin and its attachments are so small that they can be thoroughly cleaned between harvesting any two crops, so that the mixing of seed is prevented."

IRRIGATION IN QUEENSLAND.—In view of the possibilities for cotton growing in Queensland, attention may be called to an article on Irrigation in Queensland appearing in the *Queensland Agricultural Journal*, July, 1923, p. 4, and following numbers: August, 1923, p. 102, and September, 1923, p. 168.

DISEASES, PESTS, AND INJURIES, AND THEIR TREATMENT.

Under this head it is intended to give as complete a list of papers upon these subjects as is found to be practicable. Whether the pest is found in the Empire or abroad is immaterial, and in any case a knowledge of pests possible of introduction will be of use to those who may be responsible for legislation for the protection of cotton in any given country.

"PRELIMINARY NOTE ON TWO MINOR PESTS OF THE EGYPTIAN COTTON CROP." (By T. W. Kirkpatrick, B.A., F.E.S., Entomologist, Ministry of Agriculture, Egypt. Tech. and Scientific Service, Bulletin No. 33. Published by the Government Publications Office, Ministry of Finance, Dawawin, P.O., Cairo. Price P.T.3.)

The above deals with the injuries caused by two members of the plant-bug family, close relations of which are not uncommon in other cotton-growing countries.

The study of plant-bugs has been comparatively neglected in Egypt, due, no doubt, to the lesser importance of such insects in a dry climate where fungi (with which they are known to infect cotton bolls in damp countries) are not serious pests.

Creontiades pallidus may be found on cotton at Giza from the middle of May until August, when it apparently disappears, to reappear in small numbers towards the end of the cotton season. The life-cycle is rapid, probably being completed within about three weeks.

Nezara viridula is a very general feeder, and may be found on numerous plants besides cotton. Details of its life-history in this country are unknown.

Creontiades feeds on the buds, and is shown to cause a considerable amount of shedding of medium and large-sized buds.

Both these plant-bugs feed on green bolls, and their attack may be recognized by the presence of proliferations on the inside of the carpel wall. External marks of punctures are an indication, but not conclusive evidence, that the boll has been injured.

Their attack on small bolls generally results in shedding, and on larger ones in premature opening and the production of dead lint. The direct damage to the seed is not of great extent, and there is no secondary damage to unattacked seeds in the same boll, as is the case when seeds are attacked by the pink bollworm. The results are given of an experiment to ascertain how much of the totally "unpickable" bolls, and of "scarto" cotton is due to causes other than the depredations of the bollworms.

Hand-picking of *Nezara*, in the event of a bad infestation, and clean cultivation are the only feasible methods of limiting the damage that can be suggested in the present state of our knowledge of these two pests.

"COTTON PESTS (SUDAN)." (Wellcome Tropical Research Laboratories, Entomological Section, Bulletin No. 19, 1923, 38 pp. By H. W. Bedford Extracted from the *Summary of Current Literature*, B.C.I.R.A., vol. iii., No. 9; issued July 5, 1923.)

The first part of the paper explains the many injuries from insect and other pests to which the cotton crop in the Anglo-Egyptian Sudan is liable in its various stages from the seed in store to the full-grown plant in the field. The commoner cotton pests are enumerated, together with their distribution, economic importance, local names, and the measures recommended for their control. A tabular guide for distinguishing the different species of bollworm met with in the Sudan is reproduced.

"DISEASES OF THE COTTON PLANT IN WEST AFRICA." (By R. Swainson-Hall. F.L.S., in the *Textile Mercury*, September 3, 1923, p. 206.)

A brief account, with figures, of the more common diseases.

"THE PHILIPPINE COTTON BOLL WEEVIL." (By H. E. Woodworth. *Philippine Agr.*, 11 (1922), No. 3, pp. 75-81. Abstracted in *Rev. Appl. Ent.*, 11 (1923) Ser. A., No. 2, p. 94. Extracted from the *Experiment Station Record*, August, 1923, vol. lxiv., No. 2, p. 156.)

The cotton boll weevil *Amorphoidea lata* (Motsch.) is said to be widely distributed in the Philippines, where it is the most important insect enemy of cotton. The bolls attacked by the larvæ fall to the ground without producing mature seeds or fibre.

"REPORTED OCCURRENCE OF BOLL WEEVIL IN THE NORTHERN TERRITORY (AUSTRALIA)." (*Queensland Agricultural Journal*, August, 1923, vol. xx., part 2, p. 101.)

The Minister for Agriculture states that the report current in June that the boll weevil (*Anthonomus grandis*) had appeared in the Northern Territory has been proved erroneous. An enquiry has elicited the fact that in a report from the Government Entomologist boll *weevil* was mentioned instead of boll *worm* (*Platyedra gossypiella*).

The distinction is material inasmuch as the damage caused by the boll weevil is usually very much more serious than that caused by the bollworm.

To exterminate the pest, the Government Entomologist has recommended the installation of a Simon's Heat Generator appliance at all ginneries, and the isolation of the Northern Territory.

In connection with the above reported occurrence of boll weevil in the Northern Territory, Mr. Evans, Director of Cotton Culture, Queensland, states definitely that the rumour is not correct; the pest found by him both in the Northern Territory and Western Australia was the *pink bollworm*.

"GETTING ALONG WITH THE BOLL WEEVIL." (By Harry A. Mount, from the *Scientific American*, February, 1923. Abstracted from the *Agricultural Journal of India*, July, 1923, vol. xviii., part 4, p. 403.)

An account of the life and habits of the boll weevil, and of the destruction it has wrought in the cotton fields of the South.

The author contends, however, that notwithstanding the damage caused by the weevil, cotton can still be produced at a profit over most of the infested area under methods of intensive culture and close control. He also asserts that in some measure the weevil has proved a blessing, as owing to the necessity for intensive culture less acreage is required to produce a given amount of cotton, and former cotton lands are thus released for the cultivation of fruit, vegetables, and other crops for export and for home consumption.

Again, the negroes—who constitute the chief source of cheap labour in the country—are moving to the cities, and this has the effect of attracting industry. This industrial development has awakened the South to its great natural resources of coal, iron, etc., and these are being rapidly developed. Therefore, notwithstanding the destruction caused by the boll weevil, the author claims that "the South is steadily meeting the world's demand for cotton, and at the same time is consolidating her economic position in such a way that another such calamity can never occur again."

And *cf.* abstract on p. 76, "Comparative Spinning Tests."

"WEEVIL-POISONING BY AEROPLANE." (Abstracted from the *Textile Recorder*, September 15, 1923, p. 44.)

Experimental flights have proved that aeroplanes can be successfully employed to apply poison to cotton plants to destroy the boll weevil. The machines are fitted with a hopper containing calcium arsenate, and from elevations varying from 5 to 50 feet spray the poison over the cotton fields, the tremendous air blast from the aeroplane causing the calcium arsenate to be driven down on to, and to adhere to, the cotton plants.

Time tests showed that it required 2 min. 15 sec. to empty a hopper containing 120 lbs. of calcium arsenate, during which time the aeroplane was operating at an average speed of 84 miles an hour, covering 3·3 miles. The average width of the strip covered with powder was 150 feet, showing that only 2 lbs. of poison were utilized per acre.

"SPRAY-SPREADING AGENTS." (By T. Parker and A. W. Long, Bur. Bio-Technol., Leeds, Bulletin 8 (1923), pp. 252-258.)

The following note, extracted from the *Experiment Station Record* for July, 1923, vol. lxix., No. 1, seems to point to a way in which spraying, now coming so much into use in the Tropics, may be made more efficient. Detailed experiments should be made in tropical localities, to see whether the gain is worth the cost.

"Calcium caseinate greatly increases the wetting and penetrating power of a wash, and, in consequence, the active ingredients come into closer and better contact with the leaf and with the pest; the maximum effect (whether insecticidal or fungicidal) is thus obtained. A 0·2 per cent. solution of calcium caseinate is approximately the lowest strength which will produce maximum wetting. Calcium caseinate appears to influence the deposition of particles from solution and suspension, causing them to be deposited in closer proximity to one another. It greatly retards the settling of arsenate of lead from suspension. It apparently increases the insecticidal and fungicidal efficiency of some washes by 100 per cent. when these are compared with similar concentrations in ordinary water. It might be used with great advantage for assisting the penetration of washes in the control of woolly aphis. The results of the experiments suggest that winter washing with lime sulphur in conjunction with calcium caseinate might be successfully carried out at a dilution of 1 in 40 instead of at the present winter strength of 1 in 20."

"TURKEYS IN THE COTTON FIELD." (Extracted from the *Queensland Agricultural Journal*, August, 1923, vol. xx., part 2, p. 114.)

A writer in *The Reliable Poultry Journal* (March), discussing the practical side of turkey breeding and rearing, says that turkeys do a great service to farmers in the United States by cleaning up insect pests. Turkey raisers in the South, especially, have found that the presence of a flock of turkeys in their cotton fields means a big reduction in the damage caused by the boll weevil.

"WEATHER DAMAGE TESTS ON COTTON." (U.S. Dept. Agr. Off. Rec., 2 (1923), No. 9, pp. 2, 3. Extracted from the *Experiment Station Record*, vol. lxix., July, 1923, No. 1, p. 33).

"Experiments by R. L. Nixon indicate that most of the damage to improperly protected cotton is from the moisture absorbed from the ground rather than from direct rainfall. Most so-called country damage can be prevented by putting the bales on timbers and turning them after each rain so they will dry out properly. Compressed cotton did not absorb as much moisture as flat cotton, but the damage was much greater than in flat bales absorbing an equal amount."

Cf. also abstract on p. 75, "The Action of Light on Cotton."

BREEDING.

From the Report of the Carnegie Institute ("Work of the Department of Genetics," 1921, pp. 101-122, 152, 153, Fig. 2) abstracted in the *Experiment Station Record*, July, 1923, vol. lxix., No. 1, we extract the following statement:

"Preliminary observations at Sacaton, Ariz., in 1920 indicated that Egyptian and Upland cotton differ in their sap properties. Careful plantings were made at the co-operative testing station at Sacaton for the purpose of a more exact comparison of Meade and of Acala Upland cotton with Pima Egyptian cotton, and of the F_1 hybrid between Pima and Meade with the two parent species."

"INBREEDING IN COTTON AND ITS IMPORTANCE TO THE PLANT BREEDER." (By S. C. Harland, D.Sc.(Lond.), F.L.S. See *Agricultural Journal of India*, vol. xviii., part 5, p. 465.)

Summary (p. 473).—(1) The conclusions of Leake and Ram Prasad on the evil effects of inbreeding in cotton need revision in the light of recent genetic investigations. Their cases of alleged reduction in fertility as measured by the ability of selfed plants to set bolls are discussed, and it is pointed out (*a*) that the results are not statistically significant (*b*) that the neglect of environmental causes of shedding preclude the data from being accepted for critical purposes.

(2) The appearance of a partial degree of male sterility in Leake's cultures is brought into line with observations made by other workers, and it is thought that the cases of contabescence observed by him are either of the environmental type or due to the segregation of lethals.

(3) A case of complete " male sterility " in Sea Island cotton is considered as due to genetic causes.

(4) Continued inbreeding has not been found to result in progressive diminution in fertility as measured by percentage of ovules set, either in Sea Island (Harland) or Kumpta (Kottur). On the contrary, it is clear that inbreeding may result in the isolation of types more resistant to shedding than the commercial ancestors.

(5) Continued inbreeding does not necessarily lead to sterility as measured by abortion of pollen grains, for such abortion is not more frequent in elementary species or pure lines than commercial stocks or first generation hybrids.

(6) The position of cotton when homozygous is analogous to homozygous lines of maize or to pure lines of a normally selfed crop, such as the garden pea. Inbred lines of cotton are in no way distinguishable from commercial stocks except in a reduction of general vigour, which is usually slight and of little consequence to those engaged in cotton breeding.

LEGISLATION.

Under this head reference will be made to recent legislative enactments that affect cotton cultivation. The advisability of publishing more details is under consideration, and expression of opinion is invited.

EGYPT: *Legislation Agricole et Vétérinaire.* (Reprinted by order of the Minister of Agriculture, Egypt. Published by Bureau des Publications du Gouvernement, Ministère des Finances (Dawawine, P.O.), Le Caire. Prix, P.T.10.)

This publication includes among other things the laws relating to the protection of cotton (pp. 11-34).

Law No. 41 of 1920, decreeing measures for the prevention of the mixing of different varieties of cotton seed.

Law No. 6 of 1913, having for its object the prevention of the propagation of the cotton worm (*Prodenia litura*) by the cultivation of " Bersim."

Law No. 11 of 1918, dealing with measures to be taken for combating the cotton-worm pest.

Resolution of October 5, 1918, concerning the cotton-aphis disease (*Aphis gossypii*). (Mann el Kotn El Nadwa el Assalia).

Resolution of February 15, 1919, relating to the disease of the Hibiscus Mealy Bug (*Dactylopius sp.*).

Law No. 20 of 1921 decreeing measures for the destruction of the spiny cotton bollworm (*Earias insulana*) and the pink bollworm (*Platyedra gossypiella*).

Resolution of August 31, 1921, dealing with the destruction of worms contained in cotton seed in the cotton ginneries.

QUEENSLAND. (Extracted from the *Queensland Agricultural Journal*, July, 1923, vol. xx., part 1, p. 58.)

"*Extension of Cotton Proclamation.*—Proclamations have been issued under the Sugar Acquisition Act further extending, until July 31, 1923, the existing proclamations by which all cotton grown in Queensland is acquired by the Government under that Act."

(From the *Queensland Agricultural Journal*, August, 1923, vol. xx., part 2, pp. 87, 88.)

In his speech at the opening of the First Session of the twenty-third Queensland Parliament, His Excellency the Governor stated that among other measures to be submitted to Parliament would be a Bill to provide for the adequate control of the cotton industry.

CHEMISTRY AND PHYSICS, ETC., IN THEIR APPLICATION TO COTTON PROBLEMS.

Under this heading the publications of the Shirley Institute are in many ways among the most important. No one who is working at the scientific side of the cotton industry can afford to be without them, and at the present time they contain (as the titles given below indicate) many articles working up, and giving references to, the scattered literature dealing with many technical points.

The following are from vol. ii., 1923, of *Shirley Institute Memoirs*, July, 1923:

"THE MEASUREMENT OF THE MECHANICAL PROPERTIES OF COTTON MATERIALS." (A summary of the literature. By Frederick Thomas Peirce, B.Sc., A.Inst.P.)

"THE EFFECT OF HUMIDITY AND TEMPERATURE, REGARDED AS CONDITIONS OF TESTING, ON THE STRENGTH OF COTTON YARNS AND FABRICS." (A summary of the literature. By Alexander Robert Urquhart, B.Sc., A.I.C.)

"THE MACHINES COMMONLY USED IN THE COTTON INDUSTRY FOR THE TESTING OF MATERIALS." (By Edward Midgley, B.Sc.)

From vol. ii. of *Shirley Institute Memoirs*, August, 1923.

"THE MERCERISATION OF COTTON." (A review of the literature. By Douglas Arthur Clibbens, Ph.D.)

"THE PHYSICAL CAUSES OF LUSTRE IN COTTON." (A summary of the literature. By Albert Adderley, A.R.C.S., B.Sc., D.I.C.)

"SIZING." (A review of the literature. By Frederick Denny Farrow, M.Sc.)

"THE SWELLING OF COTTON CELLULOSE." (A summary of the literature. By George Ernest Collins, M.Sc.Tech., A.I.C.)

From *Shirley Institute Memoirs*, vol. ii., September, 1923.)

"THE ACTION OF LIGHT ON COTTON." (A summary of the literature. By Percy W. Cunliffe, Ph.D., A.I.C.)

Shows the great effect of light in destroying the good qualities of cotton. This suggests one minor cause, at any rate, for the poor quality of some of the Indian cotton, which is not picked at once when the bolls open, but is left till some of it falls, the money-lenders who finance the crop objecting to early or frequent picking that they cannot supervise.

"TECHNOLOGICAL RESEARCH ON RAW MATERIALS AND ITS RELATION TO PLANT BREEDING." By B. C. Burt, M.B.E., B.Sc., Secretary Indian Central Cotton Committee. (Abstracted from the *Agricultural Journal of India*, July, 1923, vol. xviii., part 4, p. 374.)

In this paper the author deals with the necessity for a more thorough knowledge of the factors responsible for the "commercial" quality of cotton and other crops. He gives the names of several organizations which are now working for the improvement of the cotton spinning and manufacturing industry from various aspects, viz.:

The Empire Cotton Growing Corporation, specializing in the encouragement of improved cotton growing in various parts of the Empire;

The British Cotton Growing Association, organizing marketing facilities for new cotton-producing countries;

The Research Department of the Fine Spinners' and Doublers' Association, and the British Cotton Industry Research Association, engaged on research work, the object of which is "to achieve a better understanding of cotton as a raw material, and of what happens when it is spun."

With regard to new cottons, the author states that facilities should be provided for proper testing, in order to prevent undesirable types being brought into cultivation. Testing of small samples of new cottons on full-sized mill machinery involves great disturbance of mill routine, and is a costly procedure; the Indian Central Cotton Committee has proposed, therefore, the establishment in Bombay of a small Technological Research Department, where practical spinning tests on small samples can be carried out, and a study made of the measurable physical characteristics of cotton fibres and their relation to spinning value.

"COMPARATIVE SPINNING TESTS OF SUPERIOR VARIETIES OF COTTON (GROWN UNDER WEEVIL CONDITIONS IN THE SOUTH-EASTERN STATES; CROP OF 1921)." By W. R. Meadows and W. G. Blair, U.S. Dept. of Agr., Bulletin 1,148 (1923), p. 7. (Extracted from the *Experiment Station Record*, July, 1923, vol. xlix., No. 1, p. 33.)

Fibre from the 1921 crop of Acala cotton grown in Alabama; Lone Star, Mexican Big Boll, and Rowden, grown at different points in North Carolina; and typical North Georgia cotton grown in North Georgia, all produced under boll weevil conditions, was tested under identical mechanical conditions in co-operation with Clemson College.

The grades, length of staples, percentages of visible waste, strengths of the yarns, and percentages of average deviation or irregularity of the sizings and strengths, indicate that for hard twisted or warp yarns, if placed in order of their merit and attractiveness to a spinner, the varieties tested would rank as follows: Acala and Mexican Big Boll, Lone Star and Rowden, and typical North Georgia. The tests show the desirability, from a spinning standpoint, of fibre produced by pure-bred strains of superior varieties of cotton over that from commercial seed, even when grown in districts with an excellent reputation for character in cotton.

HISTORICAL.

The history of cotton, and its origin, will only rarely be of any interest to cultivators or spinners. The point that is in dispute is whether the cotton plant was known in America prior to the invasions of Europeans. It is usually taken for granted that this is the case, and only a few authors, but among them the most careful (George Bentham and Sir Joseph Hooker), have even suggested that this may not be the case. The matter is worth enquiry, for the subject of hybridization of cottons is to some extent involved.

COTTON. (Bot. Abstr., 1923, 12, 268, from "Africa and the Discovery of America," vol. ii., 1922. By L. Wiener. Extracted from the *Summary of Current Literature*, B.C.I.R.A., vol. iii., No. 9, issued July 5, 1923, E. 23.)

References to the early literature regarding cotton are given, from the inscriptions of Sennacherib and Theophrastus. Philological evidence is presented that cotton originated in Assyria and India, and that it was not introduced into Egypt or Europe until the Arabic conquest. The author regards the statements in Pliny, other than those copied from Theophrastus, as largely interpolations of a much later date. The author suggests that if the accounts of Columbus and the early explorers are correct, *Bombax ceiba** rather than *Gossypium* was the plant meant by "cotton." Since Columbus brought seeds of a number of plants on his second voyage, it is probable that he imported cotton, a crop perhaps new to the Indians since they were so reluctant to cultivate it. Most of the native cloth was made from the maguey. Cotton culture in Mexico is discussed in detail with a survey of all available references in sixteenth-century literature. With regard to Peru, it is suggested that cotton was introduced at the Conquest by the negro overseers. Evidence is given that the presence of cotton in graves is no safe criterion of its antiquity.

MISCELLANEOUS.

Under this head will be noted articles that cannot readily be classified under any of the more definite headings given above.

COTTON. (Abstracted from *The Imperial Institute Bulletin,* 1923, vol. xxi, No. 1, p. 192.)

A short statement is here given of the work on cotton carried on by the Imperial Institute during the last twenty years, including the supplying of information regarding the cotton growing industry, and investigations of the quality of cottons grown in all parts of the world. These investigations have, in many cases, led to the establishment in British Colonies of new types of cotton and the improvement of existing types—*e.g.*, the development and improvement of "Nyasaland Upland" has been largely due to the help afforded by the Institute to the Department of Agriculture of the Protectorate.

Assistance in the establishment of improved cottons has also been rendered to Uganda and to other countries.

One great difficulty that is met with at present in trying to extend the cultivation of cotton is the lack of trained men, and in view of this the wider the publicity that can be given to such notices as the following the better.

COTTON RESEARCH STUDENTSHIPS. (*Agricultural Journal of India,* September, 1923, vol. xviii., part 5, pp. 532-533.)

In order to build up in India a corps of qualified investigators in cotton problems, the Indian Central Cotton Committee will award this year Six Research Studentships. These Studentships will be of the value of Rs. 150 a month, and, subject to a satisfactory report of the first year's work, will be tenable for two years.

It is the intention of the Committee to allocate students to the various institutions in India offering facilities, and each student will be expected to carry out, under direction, a specific piece of research work on cotton.

Candidates must be graduates of Indian universities, and when making application must state age, present employment (if any), and give particulars of any previous research work carried out, and full details of university career, with copies of testimonials, etc. Applications in the first instance to be submitted to the Director of Agriculture of the applicant's Province or State, or in the case of Sind to the Deputy-Director of Agriculture, Karachi. Selected applicants must be prepared to attend at Bombay for interview at their own expense.

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* A "Kapok."

Studentships for 1923-24 are provisionally allotted to the different branches of agricultural science as follows: Botany (cotton-breeding), 3; entomology (cotton pests), 2 or 1; mycology (cotton diseases), 1 or 2.

COTTON STALKS. (Abstracted from *The Imperial Institute Bulletin*, 1923, vol. xxi., No. 1, pp. 42-43.)

The possibility of utilizing for paper-making the stalks left after the cotton crop has been harvested has been investigated with Indian samples from the Central Provinces and the Punjab.

The stalks furnish pulp of fair quality which can be bleached, but the yields are rather low. The results, however, were sufficiently promising to justify further consideration, and it has been suggested that large-scale trials should be carried out, preferably at paper mills in India, with cotton stalks, both alone and also mixed with other materials.

[The supply of material for making paper, like the supply of raw cotton, shows signs of running short, and if the increased supply of the latter which everyone hopes to see could be made incidentally to help the former, both industries would be benefited.]

COTTON RESEARCH BOARD, EGYPT.

The Second Annual Report of the Cotton Research Board in Egypt seems to give evidence that research has been initiated into the varied problems of the cultivation of cotton. New laboratories have been equipped and staffed.

The first section of the Report opens with a note on the decline in yield of Egyptian cotton; evidence is produced which points to the conclusion that with attention to seed selection and careful cultivation the Egyptian crop could be improved in quantity and quality. The tests of the past two years show that Sakel grown from Domains' seed and Dr. Balls' variety "No. 310" have proved by far the most profitable commercial varieties grown in Lower Egypt.

The second section deals with experimental work on the bollworm, extraction of pure lines, bulk selection and propagation of selected strains, field tests of varieties, hybridization, growth and flowering curves, bud and boll shedding, sore-shin, and wilting.

The third section gives the programme of experimental work for 1922.

The Report, which is illustrated by charts, concludes with four summaries of literature upon cotton in Egypt and in the rest of the world, and appendices dealing with the Egyptian climate, cotton legislation in 1921, Egyptian moneys, etc.

"THE INTERNATIONAL COTTON BULLETIN" for September, 1923, contains several articles whose perusal is indispensable to those who are interested in cotton, whether its production or its consumption. Chief of these is the Condensed Report of the American Cotton Crop Investigation Commission. The Commission formed the conclusion that the South is losing its cotton crop because the small farmer can no more bring forth, on an economic basis, the cotton required by the world. The Report is divided into the following chapters:

I. *The Future of U.S.A. Cotton Production.*—Containing information under the following headings: The results of the restriction of labour immigration into the U.S.A. on wages. Costs of cotton production. Decrease in yield of cotton owing to the ravages of the boll weevil, etc. Remedies for combating the pest. Brazil and Africa as possible competitors; need for energetic measures to encourage cotton growing in these countries. Some results of the migration of the negro from the Eastern States. Feasibility of employment of machinery in Texas and Oklahoma; need for a mechanical cotton picker. Inflation of wages.

II. *The Cotton Growers' Co-operative Movement in U.S.A.*—Causes leading to the inauguration of the Society, and the measures passed to legalize the movement. The agreement between farmers and the Society. Methods of working. Number of bales sold by Society since inception. Obligations of Society. Claims received during past year. The Associations combined in "The American Cotton Growers' Exchange"; personnel. "The Staple Cotton Co-operative Association."

III. *U.S.A. Cotton Condition and Acreage Reports.*—An outline of the organization and of the methods used by the Cotton Crop Reporting Board of the Department of Agriculture, Washington, D.C., in its condition and acreage reports.

IV. *Delta and Pine Land Company of Mississippi, Scott, Miss.*—An account of a visit paid to the largest cotton plantation in the world, owned by the Fine Cotton Spinners' Association. The working of the "Tenant Share System." Details are given of the measures taken to combat the boll weevil pest, which has caused a decline in the yield of cotton.

V. *Modern Cotton Warehouse System and Fire Insurance.*—A description of the Houston Compress Company's cotton warehouses, and the methods of working. Details are given of the extraordinary precautions taken against fire.

On pp. 58-61 is a detailed statistical table giving the calculated total World's Cotton Mill Consumption and Stock for the years 1922 and 1923 (on basis of spinners' returns made to the International Cotton Federation).

EXHIBITIONS. (Extracted from the *Queensland Agricultural Journal*, September, 1923, vol. xx., part 3, p. 198.)

From an article on the Royal National Exhibition, we extract the following as an illustration of what is possible in other places and at more local shows:

"COTTON.—A very fine educational exhibit of cotton was arranged. It included instructive texts on the culture of the shrub and the picking of cotton. Open bolls were shown to illustrate the proper and improper stages at which seed cotton should be picked, and sets of standards representing the grades of the seed cotton as it has been picked this year were on view. Varieties of cotton were arranged to show the size of boll and length of lint. Explanatory and descriptive matter relating to the merits and value of the lint of these varieties was also set out. There were also exhibits illustrating the length of staple of various cottons, and samples of cotton in the various forms from seed cotton to the manufactured product. Cotton seed and the by-products of cotton seed, dress goods manufactured from Queensland cotton, and literature and photographs relating to cotton growing in Queensland, were included in the display."

MISCELLANEOUS NOTES

THE JOURNAL OF THE EMPIRE COTTON GROWING CORPORATION

As explained on p. 6 above, this first number of the Journal is of a tentative nature, and it is hoped to receive suggestions for its conduct in future. Whether made use of or not, such suggestions will always be welcome, as will "letters to the Editor" that bear upon the subjects with which the Journal deals.

OFFICERS ON LEAVE

When an officer of a colonial Department of Agriculture (or of the allied departments of Irrigation, Transport, etc.) comes "home" on leave, he usually brings with him much information that may be of considerable value to similar officers in other colonies, or to the officers of the Empire Cotton Growing Corporation, who have to collect, collate, and use all possible information relating to cotton. The Corporation would consequently much appreciate the courtesy, if Directors of Agriculture and others would be so kind as to inform them, in advance if possible, of the names, probable addresses, and approximate dates of arrival in England of officers coming on leave. This would give the Corporation the opportunity of getting into touch with these officers themselves, and of giving the latter the opportunity of meeting with one another. A further courtesy would be conferred if the officers themselves, upon arrival, would report at, or inform, the offices of the Empire Cotton Growing Corporation, which are at the corner of Millbank and Wood Street (entrance by the first door in Wood Street) immediately opposite to the offices of the Crown Agents for the Colonies.

APPOINTMENTS

Prof. A. J. Turner, M.A., professor of Textile Technology at the College of Technology, Manchester, has been appointed Technologist to the Indian Central Cotton Committee, and will direct the Indian Cotton Research Institute at Bombay.

Prof. J. A. Todd, B.L., the well-known cotton statistician, has been appointed Principal of the Liverpool School of Commerce.

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THE
EMPIRE COTTON GROWING
REVIEW

VOL. I. APRIL, 1924. NO. 2.

COTTON GROWING IN THE EMPIRE

There can be no question that the market for raw cotton is in serious need of greater supplies, and if these can be provided by countries under the British flag, so much the better will it be for all concerned. At present we buy most of our cotton from a rich country, selling most of the products to relatively poor ones. The proposition sounds comparatively simple—grow more cotton in the Empire, and all will be well. Yet this is as difficult a problem to solve as could well be desired, and if it is solved with any approach to rapidity, the fact will be due rather to the logic of events than to other things; nothing could be a greater stimulus to cotton cultivation than the present high prices.

Leaving out of consideration here the special markets supplied by the long staple cottons, Egyptian and Sea Island, it may be said that the market has been all but entirely provided with cotton of medium staple by the United States of North America. Other countries have only been able to compete with them in the very smallest degree, if at all. It will be worth while to try to analyze some of the reasons for this preponderating success of American cotton. Had this supremacy been due to chance, it would have been lost permanently, and not merely for a time, during the five years of the Civil War.

The problem is at bottom a financial one, and America has owed her supremacy to the fact that she could produce cotton well, of good quality, and at a price with which no other nation could compete. India could compete in cheapness of production, but her cotton was of inferior quality; no other country could turn out cotton of medium staple in large quantity at a price to compete with the U.S.A.

But in recent years the whole position has been altered, with the incoming of new factors into the question. The most important of these is the ravages caused by the spread of the boll-weevil in the cotton belt of North America. This has caused a considerable diminution in the crop, and at the same time has involved many expensive measures of treatment (not always effective) and precaution, with the result of a rise in prices. Cotton can no longer be grown to profit at the old cheap rates, even when allowance is made for the general rise in cost due to the war; yet it is an indispensable product. Even at the present high prices, some of the negro labour of the cotton fields is drifting away to the superior attractions of the towns, and this is still further raising the cost of producing cotton, and tending to diminish the supply.

The general effect of the new factors which are in operation in the U.S.A. is thus to diminish the supply and to increase the cost of production. The price in Europe is therefore rising, and this tends to be accentuated by the fact that the demand for cotton goods in America has been increasing very much of recent years, so that the supply of raw cotton for Europe has been further diminished. As a result of all this, America being still by far the largest source of supply, the price of raw cotton upon the market has risen to nearly three times its old figure.

Nothing could possibly act as a greater stimulus to the extension of cotton cultivation into new fields than this prevailing high price, and the fact that the area under cotton in the U.S.A. is not extending with great rapidity goes to show that that country has begun to near its maximum effort in this direction, for of course, in new extension, America would necessarily start at an advantage over competitors. The field is therefore open to other countries to enter if they can produce cotton to a profit at the present prices, under the conditions which prevail in them. Brazil and Peru are already appearing upon the market upon a large scale, and there seems no reason why the countries of the Empire should not occupy a vastly more important place among those which provide the bulk of the supply.

If people are to grow cotton, they must be shown—for a great proportion of the potential cultivators in the Empire are ignorant villagers in countries which have been largely cut off from the general stream of civilization—that it offers as good prospects as anything else, and later they must be shown how (by improved methods, better stocks, etc.) to reduce expenses so that they may continue to make a profit even though prices may fall.

Prosperity in agriculture depends in the first place upon good conditions in regard to such physical matters as land and its availability (as promoted by accessibility, by irrigation, drainage, etc.), suitability of soil and climate, and the like, and in these respects there is little reason to doubt that many portions of the Empire are potentially as well dowered as are the cotton States of North America. It is in the other primary factors of agricultural success, in what may be called the human factors of transport, education, labour, capital, and organization, that the Empire tends to lag behind.

The population of the American cotton belt, which for a long period was able to supply all the cotton of medium staple required in the world, is under 20 millions. There are more people in the British tropical African colonies, to say nothing of India. The chief difference is the greater proportion of white men in America, but at least there is a sufficiency of potential labour in the Empire.

It is in the matter of cheap and easy transport that one of the greatest differences lies. North America is provided with easy transport from the farms to the railways, the railways are at the highest point of cheapness and efficiency, the loading facilities at the docks are excellent, and the steamship service across the Atlantic leaves little to be desired. In all these respects our tropical colonies, especially in Africa, are far behind. It is of no use to grow a crop for which there is little or no local use, unless it can be easily and cheaply carried to the market, however far away that market may be. A great and urgent necessity for successful cotton cultivation lies in the provision of cheap and good transport, and already much is being done to establish it.

Coming next to the question of capital, it does not always seem to be properly realized that without capital it is not possible to grow important quantities of any product whatever, especially one for which there is little or no local market. Capital must be expended upon rent, upon seed, upon labour, upon tools, upon manure, and what not, until the crop is actually sold, and although the return in the case of cotton is as rapid as can be hoped for, the cultivator must be out of pocket for several months. By the large capitalist or company this is expected as a matter of course, and provided for, but in the case of the small cultivator—as, for example, in India or Ceylon—the result very commonly is that he is indebted to the local money-lender for the necessary advances to carry him through the unremunerative period, and these loans are at a high rate of interest, for the security is bad. It is to get over this difficulty of capital in one of the possible ways, that the Co-operative Credit Societies, that are now proving so successful in India and elsewhere, have been founded. Without a small supply of capital the small cultivator will tend to stick closely to his food crops, whose return he knows to be certain, inasmuch as he consumes them himself. Even for such essential crops as rice, however, the natives of India, at any rate, tend to be in debt to the money-lender for advances.

Education, again, is an important consideration, and the superior education of the negro cultivator in the U.S.A. as compared with that of the cultivators in many of the African colonies, for instance, must not be forgotten.

Finally, there remains the question of organization, which in the United States has been carried to a high pitch of perfection. Without the guidance of white men this perfection seems to be almost unattainable at present, and this is another point in which our tropical colonies are behind. Men, and ever more men, are wanted.

This is but a superficial sketch of the position as it represents itself to the writer at the present time, and, of course, requires much detailed elaboration. The United States have owed their superiority to a number of factors, such as better transport facilities, better organization, and other things, but they are now beginning to reach their maximum point, and with the attacks of the boll-weevil, and the increased consumption in America itself, their export has begun to fall, while the price of raw cotton has risen. A chance such as never before came in their way is thus given to other countries which hitherto have never been able to compete upon the open market in cotton. It is now up to them to seize the chance, and become producers upon the large scale; all that they are likely to be able to produce will be easily consumed. Attention must be paid to land and its availability, to suitable climate and soil, to the provision of transport facilities, to the provision of capital and labour, to suitable education, and to the other preliminaries of successful agriculture upon the large scale. Unless these preliminary factors are kept at full working efficiency, one or other of them will become "limiting," and scientific work upon improved breeds, better methods, etc., will be of no avail.

THE EXTENSION OF RAILWAYS IN TROPICAL EAST AFRICA

Reference was made in the editorial to the great importance of the provision of suitable means of cheap transport, without which it is useless to engage seriously in the cultivation of any product such as cotton, which cannot be consumed upon the spot where it is grown. The great importance of this matter, especially in tropical Africa, which, apart from India, bids fair to be the chief Empire source of supply, has long engaged the attention of the Corporation, and it is very gratifying to be able to record that steps of the utmost importance have been taken towards the construction in East Africa of lines of railway which will not only make the existing cotton fields more accessible, but which will open up new territory suitable for the crop. The importance of the work now to be undertaken may be realized from the recent official statement that cotton cultivation in Uganda (the most important source of Empire cotton of medium staple) has "practically reached the limit which existing transport facilities permit"—in other words, of the preliminary factors in agricultural progress, without whose efficient working progress is not possible, transport is becoming the limiting factor.

The Corporation has taken a lively interest in this matter, and, indeed, took some part in its initiation, as indicated in the following notice issued by the Corporation on February 9:

"Towards the end of last year the Corporation prepared, at the request of the President of the Board of Trade in the late Government, a memorandum setting out the several means whereby in their opinion cotton growing within the Empire could be considerably and rapidly developed. In this memorandum they stated that they attached special importance to increased facilities for transport in tropical Africa, and emphasized particularly the need for a railway giving Jinja in Uganda direct access to the sea at Mombasa, and the desirability of repairing the light railway at Lindi in Tanganyika. They also suggested that the possibilities of developing the Mwanza area in Tanganyika by means of a railway to Tabora on the Central Railway, and also of opening up the potentially rich cotton area of North-West Nigeria, should be carefully explored.

"At their meeting this week, the Executive Committee of the Corporation learned with the greatest satisfaction that the Colonial Office had informed the Governors of Kenya and Uganda that Parliament would be asked to sanction a loan of £3,500,000 free of interest for five years, to be repaid in thirty-seven annual instalments, and to be secured on the revenue and assets of Kenya and Uganda. The greater part of the loan will be devoted to extending the present railway from Uasin Gishu in Kenya to Luzinga, a station on the Busoga railway north of Jinja. This railway will not only greatly facilitate the movement of the Uganda cotton crop, which is expected this season to exceed 100,000 bales, but will develop the industry in the North Kavirondo country through which the railway will pass.

"The grant of a sum of £50,000 to Tanganyika has also been approved by the Imperial Government for the purpose of reconditioning the light railway at Lindi and extending it to the coast with a view to assisting the cotton-growing industry in that area.

"This intimation was given before the change of Government, but it was understood that the present Government have endorsed the scheme in both cases.

"It was further reported that the Corporation's suggestions of a railway to Mwanza in Tanganyika and another in Nigeria had been referred by the Colonial Office for examination by the local governments.

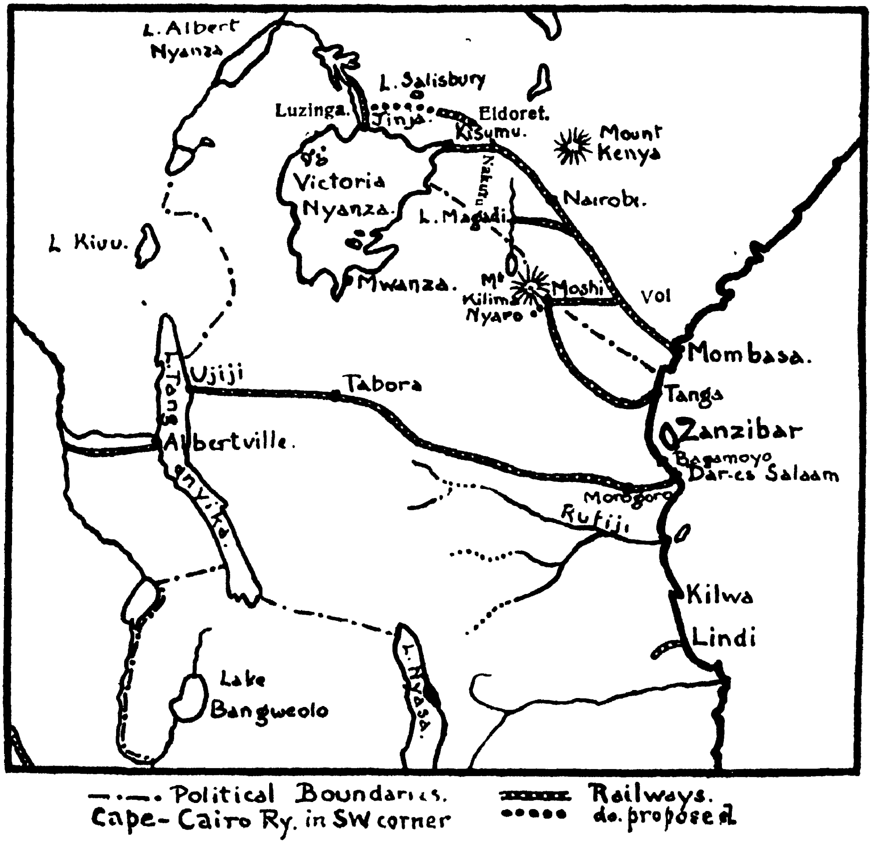
"The Executive Committee of the Corporation passed a cordial vote of thanks to the members of the late Government for the ready and sympathetic consideration they had always given to the proposals of the Corporation, and for their recognition of the importance of developing cotton growing in the Empire."

The sketch map shows the relation of these new railways to the existing lines. The Uganda railway, which as yet does not reach Uganda, has lately been extended from Nakuru to Eldoret, and at the opening of this section the Governor of Kenya stated that £5,000 was to be expended upon feeder roads. This line, which will now be extended to the exit of the Nile from the lake, makes much more accessible the Uasin Gishu plateau; the railway reaches here an elevation of over 9,000 feet, the highest in the Empire. Branches north and south from this line are also included in the scheme, while the main line below Nairobi will be relaid with heavier rails to cope with the increasing traffic.

The light railway at Lindi, originally built by the Germans, was extended during the war, and will now be improved and further extended, thus enabling the produce of the Lindi district (*cf.* this Review, January, 1924, p. 33) to be brought easily to the coast.

Another war railway which is now to be retained and improved is the linking line from Voi, on the Mombasa line in Kenya, to Kahe on the Tanga line in Tanganyika Territory, while it is also proposed to extend the Tanga line as far at any rate as Moshi, on the way to Arusha, which is a fertile district with much agriculture.

As these railways are expected to be completed in two years, we may hope to see a considerable extension of cotton production in East Africa in the season of 1926-27 at any rate, but much further extension of transport facilities will still be required before East Africa is fully opened up.



THE MARKETING OF AMERICAN COTTON

BY

A. C. NICKSON

Secretary, Liverpool Cotton Association, Ltd.

To anyone reading the title of this article it may appear a little unusual that in a journal issued by the Empire Cotton Growing Corporation space is devoted to the marketing of American cotton. The excuse for this is that the purchase and sale of practically all growths of cotton, except Egyptian, is still based upon American.

From what is reputed to be the oldest cotton bill of lading in existence, it is recorded that in 1751 eighteen bales of cotton-wool were shipped on the good "snow" or "barque" called the *Mary*, and in order to show the enormous strides that have been made in the cotton trade, I would like to draw attention to the fact that in 1914-15 4,048,000 bales of American cotton were imported into this country.

Whilst, owing to the boll-weevil, the production in the American cotton belt has fallen back in volume during recent years, yet it reached the large figure of over 16,000,000 bales during the year 1914-15, whereas in 1870-71 the production only amounted to a little over 4,000,000 bales.

Naturally the machinery for the marketing of the American crop has greatly improved in recent times, but it is still very complicated to those who have not been initiated into the intricacies of the cotton business. In this short article I shall try to deal with the marketing of that portion of the American crop which finds its way to the mills of spinners in Lancashire and other parts of Europe.

In the great cotton-growing districts in the southern States of North America cotton is mostly grown by small farmers, many of whom are coloured men. The laborious work of preparing the land is commenced about the end of February, and continued through March, April, and even May, when the planting takes place. From July to December the farmer picks his crop, collecting the seed-cotton loosely in canvas bags, which he empties into his waggon. When he has accumulated about 1,500 lbs. of seed-cotton, he takes the waggon-load to the nearest gin, where the process of separating the cotton from the seed and other foreign matter takes place. He usually obtains about 500 lbs. of lint cotton from, say, 1,400 to

1,500 lbs. of seed-cotton. The gin separates the lint from the seed, and has machinery which puts up such lint into lightly pressed bales of about 500 lbs. with a density of some 12 lbs. per cubic foot.

The farmer takes his cotton away from the gin, selling the cotton seed to seed-crushing mills in the vicinity, or to the owner of the gin. He then markets his cotton, either by offering it in the open market on the "street" in the nearest small town to where he resides, or by giving samples of it to "factors" who offer it on his behalf. The cotton is bought, either at once or eventually, by representatives of the large merchant houses which exist in America, or which represent European merchant houses, and after purchase by these merchants the cotton is despatched to the nearest steam compress, where the bales are compressed, and after compression the density is about 22½ lbs. to the cubic foot. Two additional bands are placed on the bales at the compress, thus making eight in all.

The farmer has now marketed his crop, but unfortunately is usually in the position that he has to repay overdrafts to the local banks, or repay loans to the local store from which he has obtained money to carry him through from the growing period for paying wages, buying farm machinery, seed, domestic supplies, etc.

The cotton is now in the hands of the merchant houses I have mentioned. These houses, if dealing with British or Continental importers, usually telegraph from time to time details of the grades of cotton which they have to offer, and the basis of price at which they are prepared to sell. As sales are effected, the interior merchant or shipper arranges with the local railroad agent for railroad and ocean freight accommodation to transport his goods to the European port, and immediately the cotton is received by the representative of the railroad company, such representative hands to the shipper a through bill of lading (which, being negotiable, is a very important document) giving details of the number of bales and weight of the said cotton.

The shipper then proceeds to reimburse himself in accordance with the terms of his contract with his foreign buyer. This is usually done by the seller drawing a sterling draft for the invoice amount upon the European bank with whom a credit has been opened for the purpose by the buyer. Such drafts are usually payable in London at sixty or ninety days' sight. Having drawn this draft, the shipper attaches the bill of lading, insurance certificate, and copy of the invoice thereto, which documents he presents to his local banker, together with a sight draft on a New York bank to whom he has sold his foreign draft, and in this way he receives value in dollars for the cotton which he has shipped. Bills are at times also drawn in the currency of the European country to which shipment is made.

The drawee accepts the draft under written instructions from the buyer, wherein the buyer authorizes the bank to retain as security the documents attached to the draft, and guarantees their validity.

Usually the cotton arrives before the bill matures, and the accepting bank then hands to the buyer the bill of lading in order that he may take delivery of the cotton from the ship. For this purpose the buyer gives a written undertaking to the bank to warehouse the cotton in the bank's name, and to hand the warrant (warehouse receipt) to the bank as soon as obtained, and within reasonable time. The buyer sells the cotton, and in order to effect delivery to his purchaser he obtains a warehouse release from the bank, in exchange for which he gives an undertaking to pay the bank the proceeds specifically as and when received. Should the accepted draft become due before the cotton is sold, the buyer would usually obtain a loan from the accepting bank with which to retire the maturing draft, and the bank would retain the bill of lading or warehouse receipt as security. This is the usual operation, but naturally Liverpool importers, with their great financial stability, are very often in a position to finance these operations without recourse to a bank.

There are also other methods of financing cotton stored in Europe by means of discounting bills drawn upon accepting houses, or by bills drawn by one merchant upon another, and discounted with a bank, in all of which cases the warehouse warrant would be retained by the bank advancing the money as security.

From this short explanation it will be seen that the farmer and the shipper are able to obtain cash for the cotton which they sell, and the European importer does not have to make payment until he sells the cotton and obtains the proceeds.

The period between the time when the cotton leaves the interior shipping point and its arrival in Liverpool, or other discharging port, is often many weeks, but as soon as the importer knows that his cotton is due to be landed, he presents his bill of lading to the steamship company against which he receives a delivery order.

The landing and weighing of the cotton is carried out by the Master Porter, usually under the supervision of the importer's representative. If the cotton has been sold on C.I.F. terms by the importer, instead of taking delivery of it from the ship himself, the importer hands over the " documents "—*i.e.*, the bill of lading and insurance certificate—to the spinner or the spinner's broker, upon whom the responsibility of taking delivery and paying the landing charges devolves.

The importer will sometimes sell his cotton for delivery ex quay, and in such cases the importer has the responsibility of landing the cotton, from which point it is delivered to the buyer or the buyer's representative.

In Lancashire it is customary for the spinner to buy his cotton through a buying broker. The latter acts as the agent of the spinner in supervising the quality of the cotton which he has purchased and generally watching over the spinner's interests; he also arranges for the forwarding of the cotton to the mill.

If, when it arrives, the cotton has not been specifically sold, the importer takes delivery from the Master Porter and transports it to his warehouse, where it is sampled. These samples are sent to the importer's saleroom, and are carefully selected and classified into respective lots according to marks or grades, after which—unless required to fill contracts made for deferred delivery—the cotton is offered for sale on the said samples by the latter being submitted to the buying brokers who represent the Lancashire spinners.

With the large stock usually held in Liverpool, and as a result of the large number of importers, owners of this stock, concentrated in the Liverpool market, there is naturally a very wide selection presented to the spinner—through his broker—from which to buy for his requirements, and the keen competition among importers to sell gives the spinner the opportunity of buying at the cheapest possible price.

When a spot sale has been effected the buying broker attends to the despatch of the cotton by rail or motor direct to the mill of the spinner, and the spinner must pay for the cotton purchased within ten days from the date of the invoice.

The sale just described is on what are known as " spot terms ex warehouse." A great deal of cotton also is sold on " arrival terms " or " deferred delivery terms "; such transactions usually are initiated by the importer selling cotton ahead for delivery over a certain series of months, frequently extending throughout an entire year.

The spinner, in making such purchases, is seeking to secure his quality in advance, and is anticipating the yarn sales which he will probably make during that period. Hence it usually suits the spinner, in purchasing his cotton for deferred delivery, to buy it " on call," which means that while he fixes the basis in relation to " futures," the price is not fixed until the cotton is called, and the call is based on the price of futures at the time of fixing for the month within which the delivery is to take place.

The importer may have made such sales before it is possible for him to buy the cotton from the American shipper. He, however, chooses what he considers the appropriate time to cover himself, and then makes a purchase from the American shipper, which is done either at a fixed price or on " on call " terms, in the latter case the general practice being that the shipper has the right to defer the calling of the cotton until the time of shipment.

The Liverpool futures market is very extensively used by all branches of the trade as a hedge against any variation in the price of cotton. For example, the importer buys his cotton when he considers the price in relation to futures to be satisfactory, and simultaneously sells futures against it; thus he makes a purchase and a sale, and by this means he is protected against any wide variation in the general scale of values. On the other hand, when he sells the actual cotton, he can do so without fixing the price because he has the hedge referred to, and thus, when the final buyer—*i.e.*, the spinner—calls for the price to be fixed, the importer buys in his hedge simultaneously with the fixing of the price of his sale of actual cotton.

In this article, however, I do not propose to enter into a long explanation of the uses and merits of the large future markets of the world, but I have tried to confine myself to the actual marketing of cotton.

A point which I particularly want to emphasize is that by the holding of large stocks of cotton in warehouse in England, of which, of course, immeasurably the largest portion is held in Liverpool, merchants enable the spinners of Europe to choose the exact cotton they require, the latter merely sending representatives to their salerooms, and going through a number of samples which are placed before them.

Before the machinery for marketing the crop had reached its present advanced stage it was the general practice for a large proportion of the American cotton imported into this country to come here on consignment, to be sold on behalf of the American consignor, for which service the English broker handling the cotton would be paid a brokerage.

In later years such consignments were also sent from America to some of the more important Continental cotton markets. In England the practice is less general than it was, excepting when merchants in America find an absence of demand, both domestic and foreign, for the stocks which they are carrying.

The extent to which the practice of consigning to this country is adopted is also largely influenced by the relative values of futures in Liverpool and New York, and of the "near" and "distant" deliveries in the Liverpool market. If, for example, distant deliveries in Liverpool are selling at a premium over nears, there is some inducement to consign, because of the assistance which the premium affords to the consignor, which helps to meet the cost of carrying the cotton in Liverpool; while, *vice versa*, if distant positions are at a discount an unprofitable hedging position is presented, which discourages consignments. At present, with the small crop and better prices prevailing in America than in this country, very little consignment business is in evidence, but given a large crop and a favourable hedge, there is every reason to expect that American merchants would avail themselves of the Liverpool market as a suitable outlet for their surplus stocks, and the resumption of consignments would follow.

On the European continent the situation is somewhat different, as, owing to the wide fluctuations in currencies, spinners in many cases have found it necessary to buy their cotton out of the local stocks of their own ports, and to supply that requirement merchants in America have been induced to make considerable consignments to Continental markets for sale through their agents to the spinner. These local stocks are either imported by local merchants, or represent consignments made by American shippers for sale through their agents. The spinner, by thus buying on the spot, avoids the risk of exchange fluctuations, which falls on the merchant or the shipper.

In so far as the outlook for the future of the marketing of American cotton is concerned, each year brings its difficulties. America is annually consuming more and more of her own product; last year approximately 6,600,000 bales were consumed in America, whilst the total growth was only approximately 10,000,000 bales; thus, if the remainder of the world is left to exist on the balance of small American crops in the future, the outlook would be black indeed.

There is, however, at least ground for expecting that America, encouraged by the present high prices, will grow larger crops than in the past few years; and with the strenuous efforts which are being made to combat the ravages of the boll-weevil, it is hoped that the damage done by this insect will gradually be reduced.

At the same time, one has to look forward to the increase in the growth of cotton within the British Empire, which this Corporation is doing so much to foster, and it is hoped that with foresight and accrued knowledge of the cotton trade, the British importer will buy and market Empire growths of cotton in the same way that American cotton has been marketed during the last two generations.

COTTON*

FROM A POPULAR LECTURE DELIVERED IN SECTION K OF THE BRITISH ASSOCIATION AT LIVERPOOL ON SEPTEMBER 17, 1923.

BY

W. LAWRENCE BALLS, Sc.D., F.R.S.

THE subject of this lecture is appropriate to the meeting of the British Association in Liverpool, but my title as it stands is far too wide. Any attempt to lecture adequately on cotton would carry us into contact with the work of every other section of this Association, from psychology to mathematics. In fact, at the Edinburgh meeting I had the honour of demonstrating in the Mathematical Section itself a piece of work arising out of cotton research under the pleasing title, " A Simple Harmonic Analyzer and Periodiscope," which incidentally received the further honour of finding its way into *Punch*. For the purpose of this lecture I propose to restrict the possible field very severely by attempting a popular account of some researches made during the last four years on the internal structure of a single hair of cotton. The results which I shall describe are chiefly the concern of this Botanical Section of the Association; but the additional knowledge has many possible bearings in directions other than botany, since it affects and helps our interpretation of all properties of cotton, such as its strength, its reaction to dyes, reagents, and hygroscopic moisture, together with its conductivity, flexibility, etc. By way of introduction we shall glance briefly at the story of the development of the cotton hair on the plant as it was known up to 1919; and we shall then proceed to examine the mature cotton hair in detail, first taking transverse sections through the hair, then looking at it from the side, and also in slices cut through it lengthways. Lastly, by combining the various views we have seen and attempting to trace matters back to their origin during the growth of the hair, we can construct some model of the complicated structure that will have been brought to light, notice its bearings on future botanical research and on our knowledge of the physical properties of cotton, and hint at one or two economic possibilities. Primarily, however, we are not concerned with the question of utility, but simply with the advancement of our knowledge of the cotton itself.

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* This very interesting paper describes the beginnings of work which may at a later period exercise a very important influence upon methods of cultivation and of breeding, amongst other things. Hitherto, if the matter has been thought of at all, it has been considered that, like Topsy, a cotton hair " just growed." Now it appears that its growth in thickness, at any rate, is due to the deposition of daily thickening layers, just as the growth in thickness of a tree is due to the deposition of annual layers. It is clear, therefore, that we must now study the phenomena of this growth in thickness in more detail, with special reference to its causation, so that in time we may be able to control the growth to the best advantage of the crop, possibly by a scientific use of irrigation or of other agricultural methods.

But the mere deposition of daily rings of growth by no means exhausts the complication that is found to occur in the walls of a cotton hair; and whither the discoveries of the spiral structure, of the reversals of spiral, of slip spirals, and the like may lead us must remain at present uncertain. Incidentally it is made clear why we can hardly hope ever to raise a perfectly uniform crop.—ED.

DEVELOPMENT OF THE HAIR.

Fig. 1 is included in order to emphasize one stringent structural limitation under which all knowledge of cotton suffers, and must suffer. The branching habit of the plant is such that the flowers open successively along each flowering branch, and these in their turn develop in succession along the main stem. Consequently, each boll as it ripens, having arisen from a flower opening earlier or later than its neighbours, passes through a different series of experiences with respect to weather. Hence it is highly improbable that any two bolls on one plant will develop in precisely the same environment; and from this it follows that a uniform picking of a cotton crop is unobtainable unless, as a first step, one picked only those bolls which had opened on the same day and arisen from flowers opening on the same day. We shall see later that if this were actually done, we should still not obtain uniformity, even though all the plants composing our crop were of one pure strain; for there are differences from seed to seed in one and the same boll, and also differences (with which we are to-day more particularly concerned) between the various hairs which grow upon one and the same seed.

Fig. 2 shows an Egyptian cotton flower split open lengthways to show the situation of the ovary from which the boll develops; and in Fig. 3 this same ovary is sectioned transversely to show the three double ranks of ovules which, after fertilization, develop into the seeds. It is from the single layer of epidermal cells forming the outer skin of these ovules that the cotton hairs arise. Here and there one of these cells starts to enlarge (as seen in Fig. 4), becoming eventually a mature hair. This sprouting begins as soon as the flower opens, independently of whether pollination takes place or not; and the actual number of cells which sprout in this way appears to be determined partly by the environment of the plant on the day of flowering, though largely, of course, by its inherited constitution. The actual cause which determines whether any one epidermal cell shall sprout or remain unchanged is at present entirely unknown.

The elongation of the hair proceeds until its length is approximately 2,000 times its diameter, the wall remaining very thin and apparently structureless. Then, when full extension in length has been completed, the mechanism of growth changes, and the protoplasm (living substance) which lines the inside of this long, narrow tube proceeds to lay down material on the inner wall, thereby increasing the wall thickness, and so making the hair stronger. At length the boll cracks, exposing the cotton, the hairs of which dry up and die, falling as they die into the characteristic spiral form which (in order to avoid confusion with the twist of yarn) we describe as convolutions. In Fig. 5 the story of this development in one particular kind of cotton and one particular climate is shown on a scale of three-day intervals. It can easily be realized that any changes in weather and the like which act during the first half of the growth period of the boll will affect the length of the lint, while changes acting during the second half of the growth period will modify the strength of the lint hairs. Parenthetically it may be repeated that the strength of the lint hairs is very far from being the same thing as the strength of the yarn spun from them; in fact, the paradox holds good that, other things being equal, the weaker the hair the stronger the yarn.

GROWTH RINGS.

From this introduction we can now turn to a more detailed examination of the cotton hair itself. As a precaution we might observe (Fig. 6) the group of transverse sections across a number of hairs taken at random from Sakel cotton, in order to emphasize the point already mentioned concerning the enormous variability from one hair to another. We have here hairs with walls so thick that they can scarcely collapse into convolutions on death, and others with walls only slightly thickened. The mature cotton has, as will be seen from these sections, no true diameter, being of irregular form in cross-section. But before it collapses it is a cylindrical tube, though it is evident from this figure that even in respect to the original diameter of the uncollapsed tube there are notable differences from hair to hair.

For a long while it had been suspected that there might well be textural differences between the wall-substances of hairs derived from different kinds of cotton, even if they presented the same appearance in cross-section, but that any differences in the texture

I.

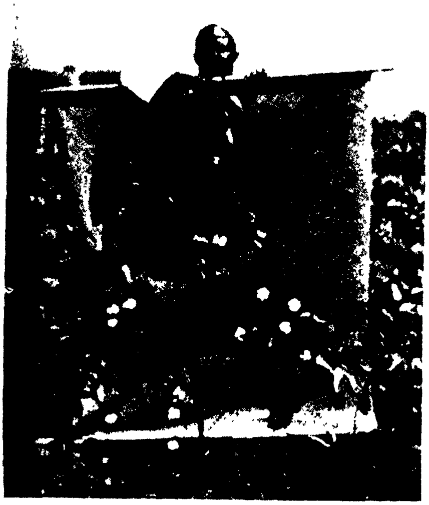
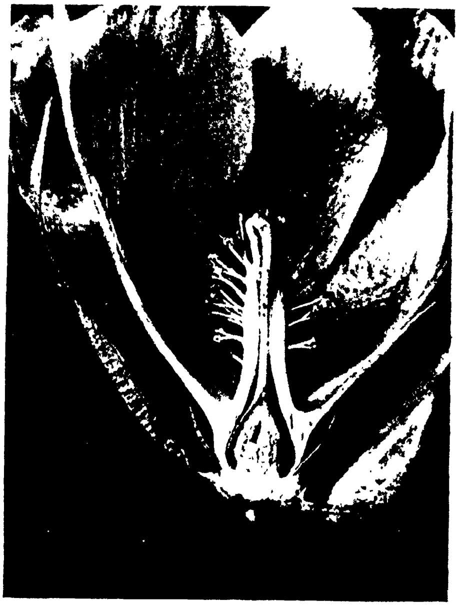


Fig. 1.



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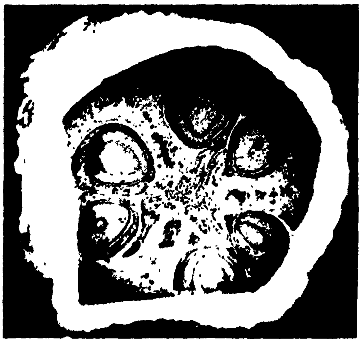

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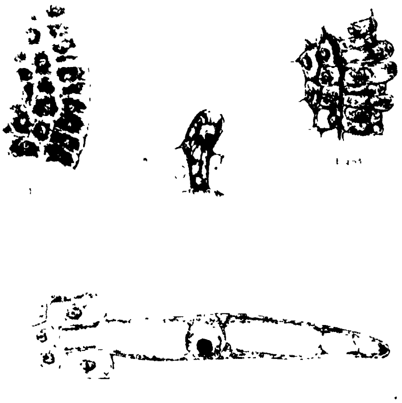

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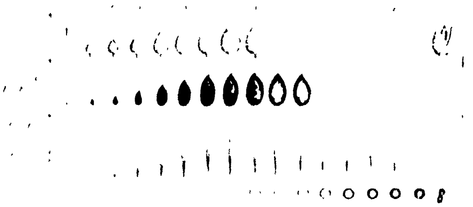

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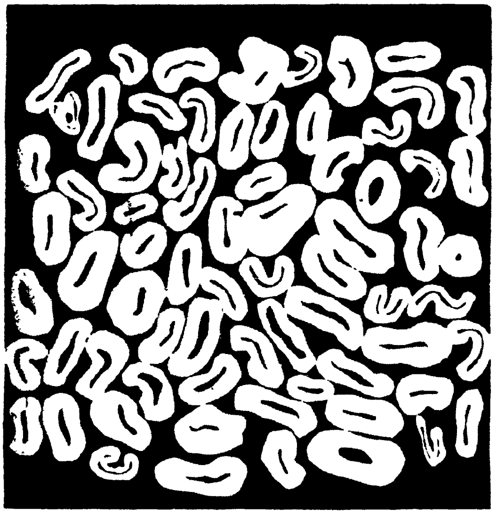

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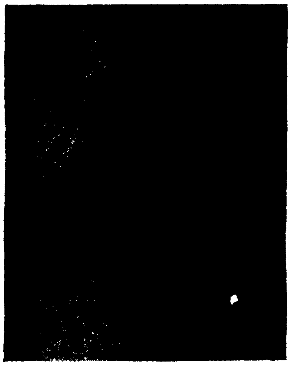

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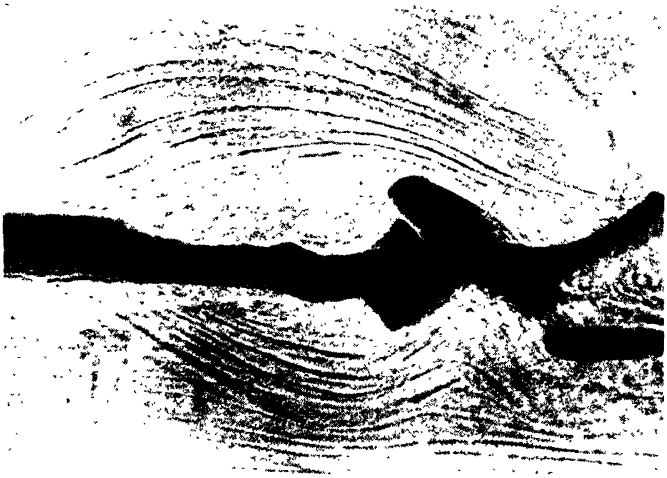

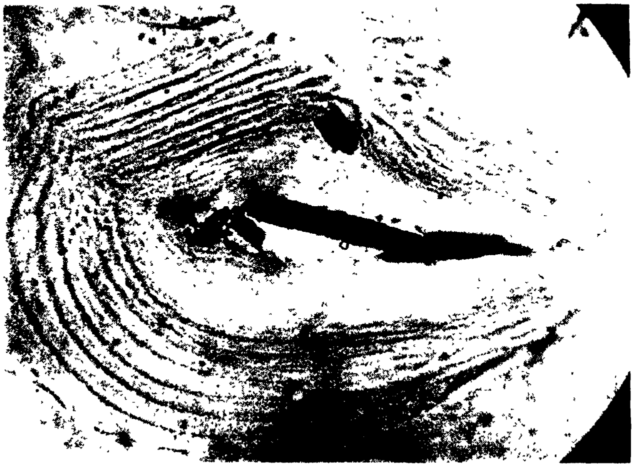

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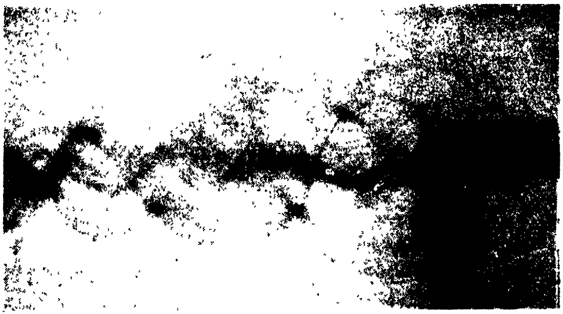

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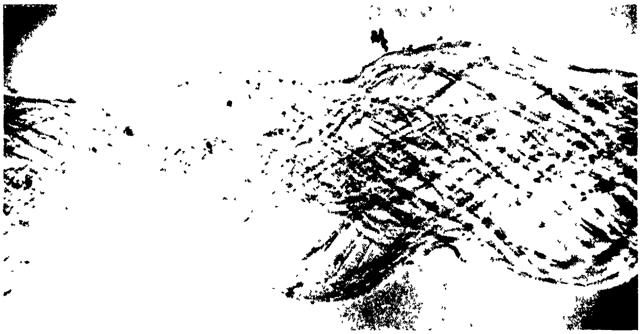

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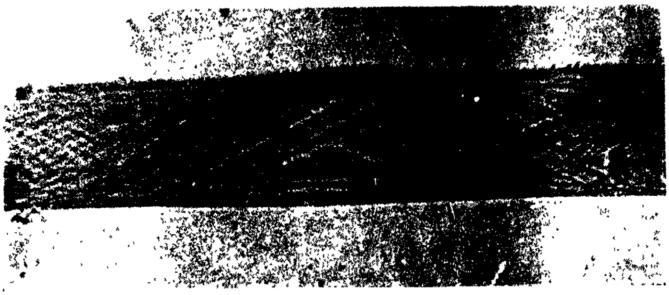

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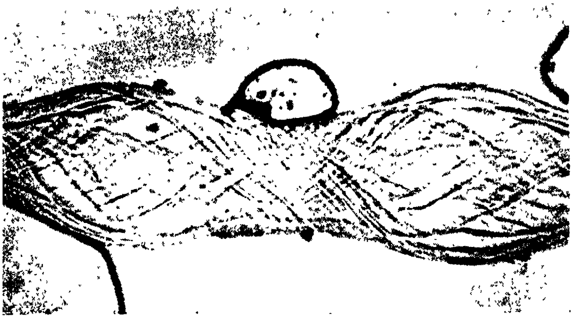
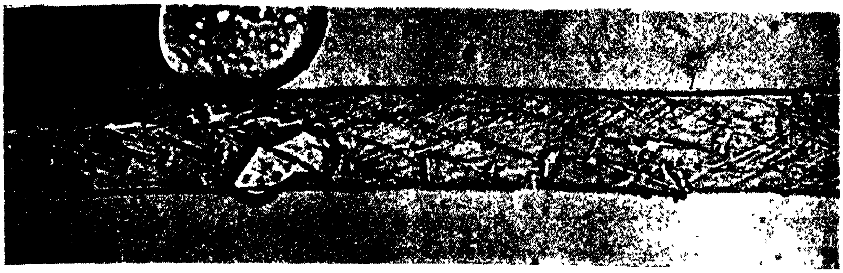


FIG. 14.

FIG. 15



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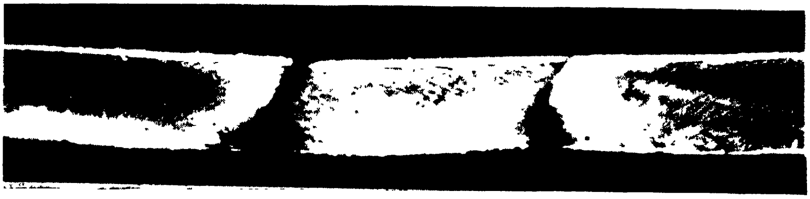

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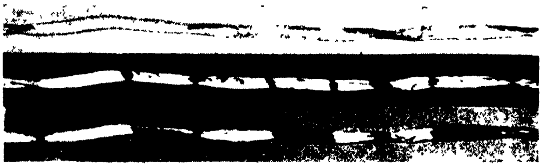

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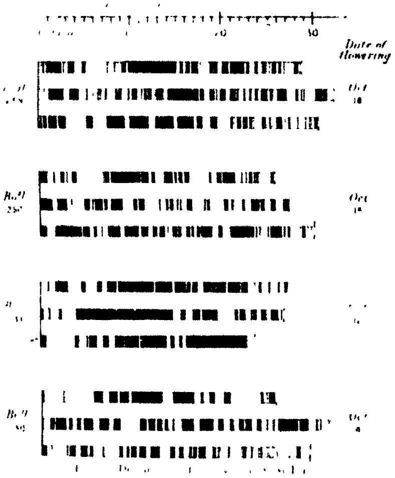

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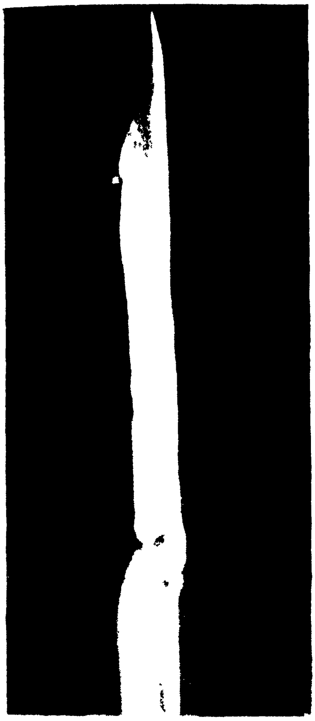

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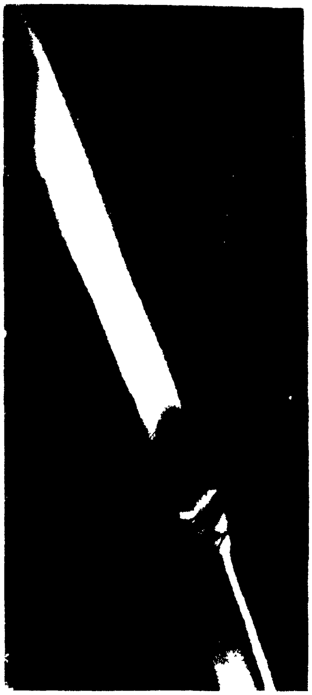
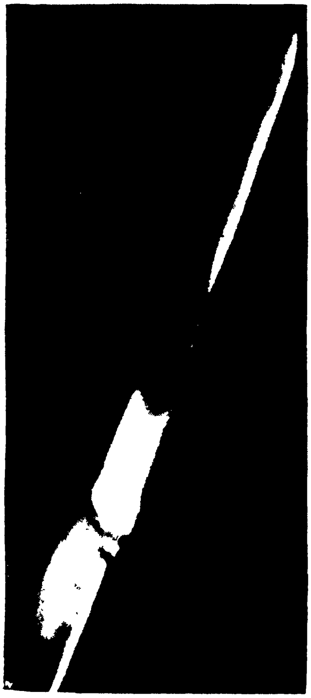


Fig. 22.

Fig. 25.



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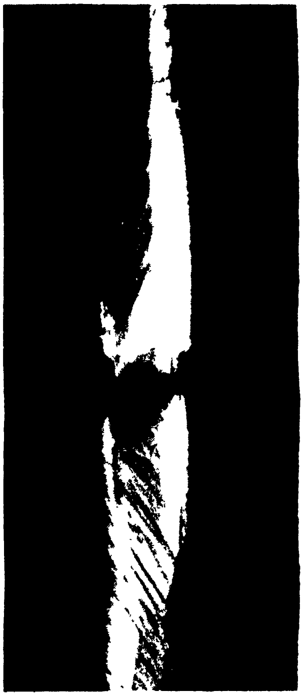

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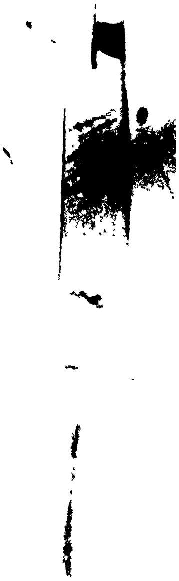

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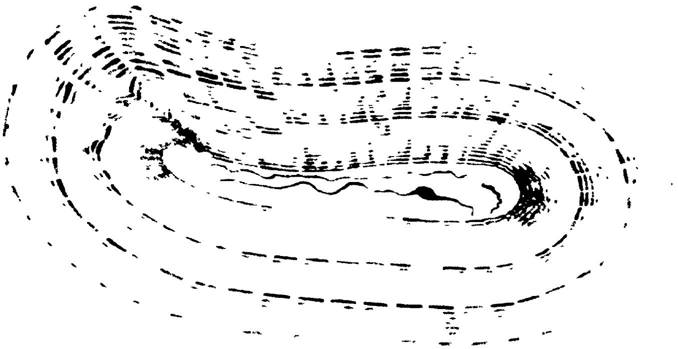
FIG. 28



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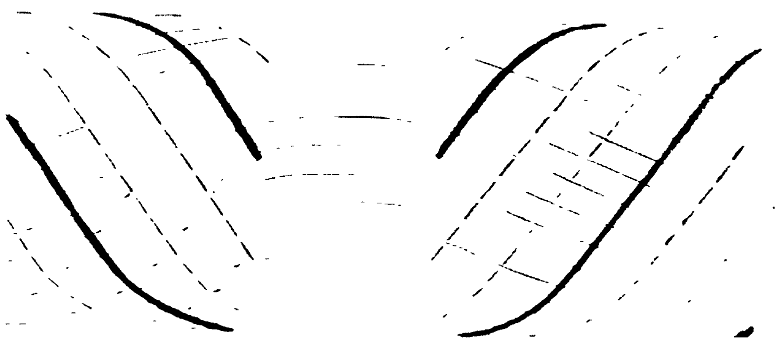

FIG. 30.

of the cellulose of which the wall is constructed would be far beyond the limits of visibility with the microscope. We had found in Egypt that the cotton plant practically ceased to grow in sunshine owing to the heavy demands made on the water supply of the plant for the purpose of keeping it sufficiently cool by evaporation; and from this it seemed highly probable that a similar cessation of growth would take place in the development of the hair inside the boll; and consequently that the deposits of cellulose constituting the wall really consisted of some thirty separate " growth rings " laid down night by night during the latter thirty days of the boll-maturation period. At the time it was impossible to test the truth of this speculation, since the thickness of such a single growth ring, as estimated by dividing the usual thickness of the wall into thirty layers, would be about 0·003 mm.; and two points which are as close together as this cannot be separated from one another by observation under the microscope. The speculation was therefore put on one side, and it was not until 1919 that a demonstration of the actual existence of these growth rings was made possible by pure accident.

It so happened that, as the result of the shortage of leather during the war, our laboratory was making up " viscose " solutions for substitute experiments. In making some of these solutions we employed cotton; and while examining some of the treacly material under the microscope an object was found like that in Fig. 7. At once it necessarily reminded me of the hypothetical growth rings, since this is just the appearance a tree trunk would present if it were made transparent and viewed from the side. Further examination showed that the discovery was even luckier, since the actual object we had found thus accidentally was not an ordinary cotton hair, but one of the short hairs called " fuzz," which coat the cotton seed at the base of the jungle of lint hairs, and which, as a consequence of this work, we have been able to show are the same as lint hairs except in two respects. These fuzz hairs have their growth in length checked, while that of the lint hairs continues; but, on the other hand, their growth in thickness is almost unrestricted, whereas that of the lint proceeds very delicately. In consequence of the latter peculiarity their growth rings are much bolder and coarser than those of the lint; and it was merely the accident of a stray fuzz hair having found its way under the microscope which led us to the identification. Eventually, by careful adjustment of the method, we were able to demonstrate that similar growth rings did occur in lint hairs; and this not only with the viscose solvent, but also with almost any reagent which will dissolve cellulose. The only difficulty was so to control the process of solution that just as the hairs had been swollen enough to bring the individual growth rings within the limits of microscopic visibility the process of solution should be arrested so as to prevent the hair from being completely dissolved. For some time we had to be sceptical as to whether these rings were real or merely illusions; but a definite proof of their reality was obtained by examining hairs taken from bolls at various stages of development, when the number of rings was found to increase in direct proportion to the age of the boll.

Fig. 8 shows a cross-section of a normal mature fuzz hair. In this will be seen the outer, or, as we term it, the primary wall, which was formed while the hair was growing in length; and then, deposited on the inside of this wall, are six successive growth rings, forming the secondary wall to which the thickness of the ripe hair is due. Fig. 9 is a very high magnification of another fuzz hair, in which we can trace seven very bold thick growth rings sharply marked off from one another, and within these are another seven very much less well defined, as if the blundering procedure of the first seven rings had been inhibited and delicately controlled during the following week. This section is particularly interesting, because it is quite unusual to find in one and the same hair rings which are typical on the one hand of fuzz and on the other of lint. The resemblance of these seven inner rings to lint growth rings will be appreciated by comparing them with those in Fig. 10, which shows a lint hair in cross-section after appropriate swelling. It will be noticed that in the lint hair we have some twenty-seven growth rings, as against many fewer in the fuzz hair; so that, whereas in the case of the fuzz the thickening is all completed in a very few days, in the case of the lint the thickening is small on each day, and is continued throughout the whole of the second half of the maturation period of the boll. It can hardly be doubted that many of the properties of cotton depend on this concentric tubular structure, and would be absent if the wall were uniform in texture throughout its thickness. A rough analogy may be drawn with the construction of cannon by casting, as in the Elizabethan period, and by shrinking successive tubes over one another, as in modern times. Later we shall find that the structure of the hair even more closely resembles that of the gun tube, which is strengthened by winding wire round it.

Spiral Structures.

We next directed our observations towards ascertaining whether any one growth ring was in itself a uniform structure, or whether it could be further subdivided. In this we were aided by another stroke of luck which may be followed from Figs. 11 and 12. In the ordinary course of events a hair swollen by one of the reagents already mentioned presents an appearance like that of Fig. 11; the cellulose has been altered to a jelly, and is girdled by bands representing the shattered film of cuticle, or skin, which covers the whole of the outside of the hair, and of which we have previously spoken; while down the centre run the remains of the dead protoplasm. This appearance has been entirely familiar for many years; but in the course of our attempts to see more in it, after we had found that growth rings could thus be shown, we occasionally found objects such as that in Fig. 12, which for convenience we called the basket-work structure. The cause of this baffled us for a long while, until my assistant, Mr. H. A. Hancock, solved the puzzle by showing that if a single cotton hair was placed under a thin glass cover-slip and pressed with the point of a penknife, it would, on subsequent swelling, reveal this basket-work structure. We found later that, though this break-up was facilitated by mounting in such liquids as caustic soda (Fig. 13), it could also be obtained without the use of any reagent, simply as the result of carefully graduated pressure (Fig. 14); and in the hairs thus treated it was found that the basket-work was actually a spiral structure, and not a mesh of crossing threads. There appeared to be no part of any cotton hair which would not show this spiral structure under treatment. Hairs such as that in Fig. 14 became interesting, because it is by no means unusual to find cotton hairs taken straight from the boll, without any ill-treatment whatever, which present the same appearance of spiral markings, especially on the inside of the wall. The existence of these spiral markings has frequently been recorded in the past, and the actual observation of them is nothing new; but it has not formerly been appreciated that they exist in every part of every cotton hair. Our next step was to try and demonstrate these spiral structures in sections of hairs; so we tried applying pressure to sections, and we also cut sections of hairs which had been pressed, but without any marked success. Such a section as that shown in Fig. 15 was about the best we could obtain. We could, however, see clearly that the cracks produced by our pressing method run right through the whole thickness of the secondary wall; so that the spiral bands behaved as though they were continuous through all the thirty growth rings, just as if the pattern of the spirals has been laid down, or, as we call it, " predetermined," on the original thin primary wall. Having once been laid down, this pattern was afterwards strictly preserved during the deposition of all the subsequent growth rings. Since these spirals occasionally leave gaps which are actually visible in undisturbed hairs, when these are taken straight from the green boll and not allowed to collapse into convolutions, we called them "Pit Spirals," on the analogy of similar simple pits found in the walls of many plant cells. There is, however, another kind of spiral; this was first seen by us in cotton which had been weakened by acid, as in the familiar dilapidation of the overalls worn in a chemical laboratory. The appearance of a hair thus weakened and then very lightly pressed is shown in Fig. 16. It will be seen that the cracks appear to be attempting to fall into two spirals, more or less at right angles to one another; and by the change of direction first to one, then to the other, we produce cracks rather like a conventional lightning flash. This second kind of spiral, to which we shall return presently, is a slower spiral than the pit, and was by us called a "Slip Spiral," to bring it into line with certain observations made by Dr. W. Robinson* on the structure of timber.

Spiral Reversals.—It was noted many years ago that the convolutions (*cf.* p. 97) formed externally on the hair showed frequent reversal of spiral, and we found that the direction at the reversal of the pit spiral demonstrated by pressing also reversed in the same way. It therefore seemed quite likely that the convolutions might be due to this spiral structure in the wall; and, if so, the reversals of the spiral and of the convolutions should always happen at the same spot in the hair. It was at first extremely difficult to satisfy ourselves on this point, because one has to focus very carefully in order to make sure whether it is the upper or the lower side of the hair at which one is looking, so as to settle whether the spiral is right or left-handed at that particular point, especially when the hair has been flattened like a pancake in the act of pressing. Eventually, however, we found that we could avoid all manipulation of the hair by the use of polarized light. It so happens that the optical axis, as it is called, of the cellulose wall is the same as the axis of the pit spiral direction; and when the direction of the spiral changes from right-handed to left-handed, we can, by setting the hair in a particular relation to the polarized light, show up each such reversal as a black band (Fig. 17). Careful examination of this figure will show the direction of the spiral fibrils actually reversing from right to left hand and back again in the width of the illustration, with a dark band at each of the two points where the fibrils run momentarily parallel to the axis of hair.*

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* Robinson, W., "The Microscopical Features of Mechanical Strains in Timber, and the Bearing of these on the Structure of the Cell Wall in Plants," *Phil. Trans. Roy. Soc.*, B., 1920, vol. ccx., pp. 49-82.

This adaptation of polarized light to our purposes was a very great convenience, because, instead of having to focus laboriously under the highest power available, we could show up the reversals even under a low power, as, *e.g.*, in Fig. 18 (middle hair). How laborious the old method was may be realized by remembering that with the magnification used in Fig. 17 we can include about ten calibres of the hair in the width of the microscopic field, and that the length of the hair, as stated above, is of the order of 2,000 calibres; while reversals from right to left hand and back again may occasionally occur within two calibres. A further improvement in the method was obtained by using a quartz plate in the optical system, by means of which the right and left-handed spirals can be made to assume complementary colours—*e.g.*, green and crimson, or blue and yellow—and so become visible without even the trouble of searching for the dark band, which is liable to clash with a convolution, and so be missed. Fig. 19 shows a single reversal from right to left hand viewed in this way, and the colour must be imagined as green in one portion and crimson in the other. The same method is shown at the bottom of Fig. 18, where a low power of the microscope has been employed. In point of fact, the three hairs in this last figure are all the same object photographed three times in succession: first with ordinary light, secondly with plane polarization set to show the dark band, and thirdly with quartz plate set for maximum colour contrast. Evidently, therefore, the study and mapping of these spiral directions and spiral reversals has been made quite easy for future work.

At this stage, however, we come very near the frontier of research and have to admit ignorance. For being in possession of this delightfully simple method, we proceeded to make maps of the distribution of right and left-handed spirals in a number of hairs. Some of our first results are shown in Fig. 20, where we have plotted the result of mapping twelve hairs, three being taken from each of four bolls, these four bolls having ripened on one and the same plant at intervals of three days. Moreover, the three hairs examined in each case were all taken from the same tiny area of the seed coat, so that they ought at least to resemble one another fairly closely. Actually, however, as will be seen from the figure, where the right-handed spirals are plotted in black and the left hand in white, from the base of the hair to the tip, there is no obvious kind of resemblance between, *e.g.*, the three hairs of boll 230; much less is there any steady progression of type over the days included in the diagram. To test for the cause of these reversals by accumulating statistics in this way would appear at present quite impracticable; and we have therefore abandoned the statistical method in favour of direct experiment, cultivating cotton plants under conditions of constant illumination, so that there is no alternation between day and night. Our reason for doing this is that, while the numbers of reversals vary widely between one hair and another, the commonest number is in the neighbourhood of thirty complete reversals—that is to say, from right to left hand and back again; and this number at least hints to us that the reversals may mark a day's growth in length, just as growth rings mark a day's growth in thickness. This guess, for as yet it is nothing more,* is mainly based on the fact that as soon as the reversals are visible at all, which is not until growth in length has stopped and secondary thickening has begun, we find the full number to be present; which looks very much as if the deposition of secondary thickening on the primary wall was merely "developing" a pattern predetermined in the wall.

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* It has since come to my knowledge that when this and one or two other slides were shown by the very excellent lantern of the Botanical Laboratory at Liverpool University, a member of the audience was overheard to express the opinion that the photographs were faked! While the detail is not nearly so distinct in a process reproduction as it was on the screen, it may be worth while to state here that all the photographs used for this lecture were taken direct from the microscope without any retouching or alteration whatever.

Examination of these hairs in side view, especially by optical methods, is complicated somewhat by the fact that any light passing through the hair has to pass first into the hair through the lower wall and then out again through the upper wall. To obviate this difficulty we emulated the lawyers by splitting the hairs lengthways, so that we had only one thickness of wall to examine. Fig. 21 shows such a longitudinal section viewed in ordinary light. This section has been chosen for photography because it happens to have a damaged portion near the middle, making a convenient reference mark. If this section is now viewed in polarized light and turned through an angle of about 15 degrees to the left (Fig. 22), it will be seen that the portion of the hair containing the damaged area is completely blackened, while the remainder is bright. Conversely, if the section is rotated about 15 degrees to the right (Fig. 23) the conditions are reversed; and the area formerly blackened now transmits light, while what was previously the light area is now black.

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* Further research conducted since this lecture was delivered has shown the guess to be largely wrong, but the true story is even more interesting.

In Fig. 24 is a similar but different section, set in the intermediate position at which the dark band (Fig. 17) is visible; and in this the definition of the spirals is so sharp that they can be counted with very fair certainty. There would appear to be not less than sixty of these spirals in cross-section and in one growth ring.

Slip Spirals.—We can now return to the Slip Spirals, which we mentioned as taking their part in forming the lightning flash type of crack in hairs weakened by acid (Fig. 16). They are different in kind from the pit spirals in that they cannot be shown to exist in the undamaged hair, but are artifacts produced by deliberate or accidental damage, in the same way that we first managed to make the pit spirals visible, though the latter, as has already been explained, belong to the natural structure of the hair. The easiest material in which to search for slip spirals is any piece of old cotton string—the older the better—from which hairs may be extracted like those of Fig. 25, in which the slip spirals have been made exceptionally conspicuous by an unsuccessful attempt to employ a peculiar staining method. The difference in angle of these spirals should be noticed; their inclination to the axis of the hair is about 70 degrees as against an inclination of about 30 degrees in the case of the pit spiral. The slip spirals also show reversal of direction, as in Fig. 26; and, though we do not happen to have a photograph to illustrate this, these reversals are always accompanied by reversals of the pit spirals in the opposite direction. Undoubtedly the two kinds of spiral are directly inter-related, the one crossing the other at something near a right angle. The slip spiral is essentially a cleavage surface, analogous to the cleavage plane of crystals such as mica or graphite. In order to develop such cleavage surfaces we apply stress; in the case of cotton hairs the appropriate stress is obtained either by twisting or in other ways. The appearance of such hairs in longitudinal section, viewed in polarized light, is seen in Fig. 27. In this figure it will be noticed that the slip spirals appear at very frequent intervals; but detailed measurements seem to indicate that two such spirals cannot occur quite as close together as can two pit spirals. In one place in this figure, towards the margin of the field, the actual dislocation of the wall at the slip is clearly visible.

We can arrive at a clearer conception of these slip surfaces if at this stage we visualize the wall structure as consisting of a series of spiral fibrils running the full length of the hair and composed of unit structures joined end to end in chains, the joint between any two units of the chain being breakable, and the relative positions of the units being consistently such that a slip spiral develops as the result of fracture.

Origin of the Spiral Structures.—We reach the last stage of this lecture when we turn back to the unthickened primary wall, which was formed during the period of growth in length, and in which we have postulated the existence of a spiral pattern which predetermines the pattern of the secondary wall. Most unfortunately we can find no trace of any such pre-existing patterning, the primary wall being beautifully symmetrical, with no suggestion of any alternative right and left-hand structure. From this it might appear as if our views about the nature of spiral reversals were entirely fallacious; but such is not altogether the case. These views are merely the scientist's " working hypotheses " for the planning of future experiments; and our failure to find these hypothetical structures in the primary wall is only a " negative result." As a matter of fact, when we first examined the primary wall in detail we could find no trace of any structure whatever. This was due, in part, to the fact that this wall is not itself ordinary cellulose. Acting on a suggestion derived from the work of Prof. Priestley, we tried certain chemical treatment which appears to convert this "pre-cellulose" into ordinary cellulose which will take up certain stains, whereby a very faint and delicate structure can be revealed. The structure is so fine that it cannot be photographed satisfactorily without the use of polarized light. In this way the illustration in Fig. 28 was obtained with sufficient definition to be reproduced. This figure shows a longitudinal section of a hair, but in this case it is a hair which has not yet begun its secondary thickening; and in order to make perfectly sure that the sections are true sections showing only one thickness of cell wall, certain fragments have been selected for photography in which the cut is slightly oblique, so that the section, when opened out, takes the form of a Y. On inspection it will be seen that the wall structure consists of a cross-hatching of very fine lines, these lines running at about the same inclination to the axis of the hair as do the slip spirals. We may regard the structure of this wall as showing two opposed sets of spirals, right and left-hand directions co-existing in the same piece of wall. From the agreement of the angle of inclination with that of the slip spirals, it is not improbable that the latter represent the lines along which the cellulose of the secondary wall " crystallizes." To use the analogy of crystallization for such a typically plastic organic substance would have seemed quite inadmissible a few years ago; but the illustrations of polarized light effects which have been seen make it evident that this analogy is by no means far-fetched.*

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* Similar cross-hatched appearances are shown by viscose and cuprammonium artificial silks, but not (a significant fact) by acetyl and nitro silks.

But we are still confronted with the difficulty that in order to study the origin of the reversals of the adult structure we need to trace their development while the hair is growing in length; and we cannot do so because, during that growth in length, no such reversals are to be observed. That we cannot observe them does not necessarily mean that they do not occur; and possibly one more stroke of luck may enable us to demonstrate that the apparently uniform structure of Fig. 28 is, in fact, not uniform. For instance, it may be that the right and left-handed twinned spirals change places along the hair, sometimes one of them being innermost and sometimes the other. This change would not be visible by any method as yet at our disposal.

In order to bring the whole of this complicated structure into tangible form, I have ventured a diagrammatic representation fairly true to scale and co-ordinating the previous illustrations. Fig. 29 shows the hair in cross-section broken up into the units which our analysis has shown to exist; the same object is supposed to be seen in side view at a reversal point in Fig. 30. Perhaps the most striking feature of these diagrams is their indication that the cotton hair is a "sponge." This is actually the case; for our laboratory* has shown that the density of the hair as determined by measurements of its dimensions is roughly the same as that of water, whereas its density as determined by immersion in liquids has long been known to be half as great again as that of water. Thus, in the dry state the hair wall must contain relatively enormous air spaces, and the proportions of these, as represented in Fig. 29, are not exaggerated. As a consequence of this sponginess, we are provided with a really immense surface on which dyes, water, etc., can be adsorbed. We have also an intricate arrangement of surfaces and slip surfaces in various directions; and it is quite probable that different chemical linkages take place on these different surfaces. As a mechanical structure we could scarcely design a more flexible and sensitive one than this orderly arrangement of some 2,000 spiral spring units which are packed into a single hair. The units themselves are far from being the final units of cellulose. Probably each one of these units, as shown in cross-section in Fig. 29, is in its turn compounded of a number of enormously more delicate fibrils lying side by side in orderly bundles, and each of these fibrils is composed of a chain of cellulose molecules placed end to end. The strength of a piece of cotton yarn ultimately depends on the cohesion between these molecules end to end. Some seven years ago Mr. C. F. Cross advanced the conception that problems of the textile industries, and of cotton in particular, should be contemplated and studied in terms of the properties and behaviour of single hairs. This was, at the time, to the industrialist almost a *reductio ad absurdum*; but before any but specialists have succeeded in acquiring this attitude, our unit has shrunk further from the hair to the fibril—and will shrink still further. The dimensions of these fibrils are such that a 10-kilometre length would only weigh a single milligram, so that we could "put a girdle round about the earth," not once, but more than five times over, with a single ounce of cotton.

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* Experimental Department of the Fine Cotton Spinners and Doublers Association, Rock Bank, Bollington, near Macclesfield.

The two points of most evident interest on the practical side in this story of the cotton hair are:

Firstly, the bearing of this structural knowledge on the artificial construction of textile fibres, such as the artificial silks. The latter, though possessing many advantages, do not attain to the tensile strength of fine cotton yarns; and in view of what we have seen to-day, we should not expect them to do so. With further knowledge of the molecular structure of our cotton fibrils it may eventually be possible to control deliberately the formation of a similar arrangement in the making of artificial silk, which might be very sad for the cotton industry.

Secondly, the marked individuality of every single cotton hair, as instanced in Fig. 20. So that even from the purest strain of cotton of the most uniform kind, grown under the most perfect conditions, it is impossible to raise a strictly uniform crop. This does not in any way mean that any shred of effort which might improve the uniformity of cotton supplies or the cultivation of the cotton fields should be relaxed; but it does seem to carry the implication that when everything that can be done by the grower in the way of improvement has been done, it will be necessary for the spinner to develop methods which will subdivide raw cotton into fractions of uniform composition in respect of length and fineness. However, machines for doing this last operation are yet to be invented, and it will take even longer to adopt them than to invent them.

References.—The original scientific papers utilised in this lecture were as follows:

Balls, W. L.: "Existence of Daily Growth Rings in the Cell-wall of Cotton Hairs." *Proc. Roy. Soc.*, B. 90, 1919.

Balls, W. L.: "Further Observations on Cell-wall Structure as seen in Cotton Hairs." *Proc. Roy. Soc.*, B. 93, 1922.

Balls, W. L.: "Determiners of Cellulose Structure as seen in the Cell-wall of Cotton Hairs." *Proc. Roy. Soc.*, B. 95, 1923.

THE SPINNING VALUE OF COTTON*

BY

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It is not possible completely to understand what properties are desired in a yarn without reference to the uses to which yarns are put. By far the greater part of cotton yarn finds its way into cotton cloth, so for the moment we may ignore the demand arising from other sources, such as hosiery, lace, sewing cottons, etc. Now the properties by which a cotton cloth is generally judged may be taken as (1) its appearance; and (2) its service. The consumer usually estimates both these properties by the feel and by the actual appearance of the cloth to the eye. Apart from certain special effects, it is safe to affirm that what is desired is a firm, closely woven fabric, feeling soft but full, and having a certain weight. The manner in which a cloth responds to these tests depends in a great measure upon the properties of the yarn, although it is true that modern technique in " finishing " cotton cloths makes it possible to simulate in poor materials the results usually associated with good. Still, it remains a fact that a good quality cloth requires good quality yarns.

A spinner, however, has not only theoretically to consider the properties desired in a cloth and the properties consequently desirable in a yarn, but he has also to face four limitations. In the first place, in being transformed into cloth, his yarn has to pass through certain processes, known as winding, warping, and weaving. Evidently the yarn should be so spun that it suffers as little damage as possible in passing through these processes. It is in weaving that the possibilities of greatest damage are encountered. The object in weaving is to make a fairly long piece of cloth of a given width by interlacing, in a predetermined manner, two sets of yarns at right angles to one another: the yarns running length-wise in the cloth are "warp" yarns, those running cross-wise are "weft." In order to effect the interlacing, the warp yarns are held in a horizontal plane under considerable tension in the loom; by raising some of the warp yarns relatively to others a "shed" is formed; through this shed a shuttle passes, leaving behind it a trail of weft yarn released under slight tension. A reed, which somewhat resembles a comb in form, between the teeth of which the various warp yarns are drawn, receives a to-and-fro motion, such that it is in its rear position when the shuttle is passing through the shed, and comes forward after this to "beat up" the weft yarn which the shuttle has just left behind. The rapidity of the reed's motion may be gauged from the fact that 200 or more weft threads may be inserted in one minute on a power loom. In moving backwards and forwards the reed rubs against the warp drawn through it, and so tends to weaken the warp; the lifting of the warp to form a shed also subjects it to additional stress, so that in view of the comparatively high initial tension to which the warp is subjected, it is clear that the warp yarns in weaving may be severely strained; often, indeed, they are strained to breaking point (especially if they are fine yarns). The weft yarns, on the other hand, are subjected only to slight tension in weaving, and seldom break. These exigencies compel the spinner to spin strong yarn for warp, but not necessarily for weft. The effect of this will be referred to later.

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* The complex processes through which a bale of cotton has to pass before it comes out as the finished article are here described in simple language which should enable the cultivator to understand better what actually happens to the product which is the result of his labours. The paper suggests directions in which the cultivator should work, as, for instance, towards the greatest possible cleanliness, and also suggests various considerations to the breeder, such, for example, as to whether it might not possibly be worth while to breed separately for warp and for weft cotton, instead of leaving the purchaser to buy different kinds of cotton, as he sometimes does at present, for that end. The article contains much that is of interest to the man who is concerned with cotton as a growing organism, and much with which he should have at least a working acquaintance.—Ed.

The second limitation which the spinner has to face arises from the raw material. The great differences between different types of cotton reappear in some form in the spun yarns. Moreover, the raw cotton, even of one type, shows much variation from fibre to fibre, has much foreign matter mixed with it, and has been heavily pressed for ease and cheapness of transport.

The third limitation confronting the spinner arises from the processes through which the raw fibre has to pass when being converted into yarn, and the degree of success attained by the machinery invented for achieving the desired end.

The fourth limitation confronting the spinner is an economic one. The higher price which he may receive for a better quality yarn may not recompense him for the additional cost of production; he must evidently aim at producing that quality of yarn which is most remunerative under the given market conditions with the spinning plant at his disposal.

The spinner, then, while attempting to provide yarn which will give the desired characteristics in cloth, encounters limiting factors in (1) the raw material; (2) the machinery available for converting the fibre into yarn; (3) the processes necessary in converting the yarn into cloth; and (4) economy of production. Bearing in mind these factors, we may set down the normally desirable yarn characters as: (1) Cleanliness (*i.e.*, freedom from impurity); (2) regularity; (3) strength, especially for warp; (4) definite fineness or coarseness (counts); (5) appearance. In converting the raw material into yarn, the spinner aims at attaining these characters more or less in the order given. The machines for doing so are, in order of sequence:

1. Bale breaker.
2. Opener.
3. Scutcher.
4. Carding engine.
   (*a*) Silver lap machine.
   (*b*) Ribbon lap machine.
   (*c*) Combing machine.
5. Drawing-frames.
6. Fly-frames.
7. Spinning machine, either ring-frame or mule.
8. Doubling machine, either ring-doubler or twiner.

A short account of the action of these machines may assist in the understanding of the kind and degree of the mechanical action to which the cotton is subjected. It must, however, be understood that the necessity for intelligibility leads to compression and the omitting of desirable reservations from the generalized descriptions.

The machines from the bale breaker to the carding engines are largely engaged in the removal of foreign matter and in progressively opening out the hard matted lumps of cotton which are fed to the bale breaker from the bales themselves. Some attempt is also made to get regularity. Very different types exist of bale breakers and also of openers; subsequent machines are built in fairly standard forms, although many important minor differences distinguish the machines of the various makers. In the modern hopper bale breaker the lumps of cotton, fed in bulk, are penetrated by steel spikes; these effect considerable breakage of the lumps of cotton, and, further, the smaller lumps thus produced, having been penetrated in many places by the spikes, are more readily broken up in the treatment which follows. Except in an opener resembling the hopper bale breaker, the principle underlying the action of openers is to beat tufts of cotton against grid bars, first, by means of a striker cylinder, consisting of iron strips about 7 inches by 1 inch by ⅛ inch attached to discs mounted on a rapidly rotating cylinder, and afterwards by a steel-bladed beater having two (sometimes three) blades, consisting of heavy bars of steel which are mounted on, and parallel to, a rapidly rotating shaft; these blades beat small tufts of cotton from the fringe of cotton, extending across the machine, which is constantly being presented by continuously revolving feed rollers. The cotton is delivered by the opener in the form of a lap, which resembles a thick but very soft sheet of felt, and which is rolled round a rod as it emerges. Different types of openers are frequently used in combination.

Although some attempt is made to obtain regularity of flow through these machines—leading to regular yarn—it is in the next machine, the scutcher, that the principle is first applied of putting together a number of laps (usually four) with a view to reducing their irregularity. If a thick place in one lap comes just above a thin place in another lap, evidently these irregularities will tend to cancel one another; at the worst, if thick places in all four laps happen to come together, the relative irregularity at this place will remain unchanged, while the chances of this "worst" event occurring are likely to be small. The fourfold thickness of lap is then subjected to a bladed beater action, similar to that already described; occasionally for Sakellaridis cotton the other form of beater, the striker cylinder, is used instead of the bladed beater.

In the next machine, the card, the disentanglement of the cotton fibres is completed, and most of the remaining dirt removed, as well as a good deal of short or weak fibre, and "neps." The scutcher lap is fed at one end of the card, and tufts of cotton removed from it by a coarse saw-toothed "taker-in" cylinder are caused to pass between two carding surfaces—*i.e.*, surfaces clothed with finely tempered steel wire set at an angle and with a density of 500 to 750 points per square inch; a tuft of cotton between two such surfaces moving in opposite directions and having the points of their wire opposed is quickly brought to a condition in which its various fibres are separated from one another. The treatment is evidently a drastic one, but, nevertheless, it does not necessarily give rise to a great deal of waste. The amount of waste depends upon the amount of impurity present: the greater the amount of impurity, the more intense is the treatment necessary to extract the impurities. As a consequence, in addition to a greater proportion of waste being made, the value of the it does yield results in the concrete terms desired by the spinner. At the same time, it is not practicable to submit to a spinning test all the cotton which comes into the market. Instead, reliance has to be placed on the judgment of a grader, who grades (American) cotton according to the amount of foreign matter which, by visual examination, he estimates it to contain. The greater the amount of impurity in a given weight of material, the less is the amount of cotton and the less the weight of cotton yarn which can be produced from it. Cotton which contains much impurity possesses other disadvantages. It is more difficult (and more expensive) to clean; or, alternatively, the quality of the yarn suffers so that the price obtained per pound of yarn is less than from a cleaner cotton. However, it has to be recognized that the price question is also a matter of market organization. While the spinner has to pay a higher price for cleaner cotton, the actual grower may occasionally receive no higher price than that paid for the standard local cotton of inferior grade, simply because the local market conditions may be inadequate. In such circumstances it is not profitable for the grower to pay for greater care in picking the cotton.

Other factors besides grade affect the actual market value of the cotton; allowance has to be made for length of staple, strength, and colour. The valuation of a cotton for spinning purposes on this basis is evidently very much more liable to subjective errors than is a spinning test. Still, it is the method universally employed, and gives, on the whole, fairly satisfactory results—especially when the cotton being tested is of a type familiar from long experience. Where the method tends to break down is in connection with new types of cotton. The explanation is, no doubt, that other properties of the fibre are important in spinning besides those mentioned. Full understanding can only come as the result of complete investigations of the interactions of the various properties of the material, the machinery and the settings employed, and the physical conditions, notably of temperature and humidity, under which the tests and spinnings are made. Some progress in this direction has already been made, but the problem of the relation between fibre properties and spinning value yet remains a problem of the first importance. And it is a problem on which much research is still needed.

Note.—Those unfamiliar with cotton-spinning processes will find a useful introduction to the subject in two small works:

(1) "Handbook of Cotton Spinning Tests," by Dr. W. Lawrence Balls, F.R.S. Published by Macmillan and Co. 3s. 6d.

(2) "Cotton Spinning Machinery," by W. Scott Taggart. Published by Pitman and Sons. 3s. 6d.

These serve very well as an introduction to the larger works by W. Scott Taggart, Thomas Thornley, etc.

A NEW-COMER TO THE SUDAN COTTON FIELDS

After a long, dusty, and decidedly hot journey through Egypt, relieved only by a wonderful two days on a Nile steamer between Shellal and Wady Halfa, the new-comer feels only too glad to arrive at Barakat. For the last week new sights, sensations, and impressions have been crowding upon him in a blinding succession. In a strange climate, surrounded by strange peoples, with a strange language in his ears, eating strange foods, and meeting a strange sight at every turn, he feels at the same time vastly interested and rather dazed. It is as if one had been suddenly cast bodily into a cinema picture, and it is almost surprising to find that a glass of beer looks the same as in England, and that the taste of tobacco has not changed.

In Barakat he is met by a Ford car for himself, and a Ford lorry for his luggage, whose dimensions are extremely large, and which has caused him much heat and bother for the last three weeks. Barakat consists of a heterogeneous collection of buildings, grading from the Managing Director's almost palatial bungalow to the most humble and disreputable of native tukis (round huts of straw). It boasts, besides numerous large store-houses and workshops of corrugated iron, a station, a post-office, and a light railway. This last connects headquarters with the unlimited activities out in the " blue," and is the means for transporting workmen and materials needed for the erection of new bungalows many miles distant. Barakat is situated upon one of the original irrigation canals which have been the means of producing trees and gardens—such a relief in the flat shadeless monotony. It is a very small place, but what it lacks in size it makes up in ceaseless and busy activity; it is the hub of a small universe.

The new-comer, having spent the night in the rest-house and breakfasted at dawn, is " pushed off " as soon as possible to his destination among the cotton. There is plenty of work to be done, and the sooner he gets to it the better. On his way out in a lorry with his newly engaged servant behind him, he obtains some idea of the country with which he is soon to become so familiar. It is deadly flat, intersected by a network of canals which gradually become smaller and smaller until they merge into the mere furrows and ridges where the cotton grows. In July, August, and September, during the annual rains, the whole country is a carpet of green, partly of weeds and partly of cotton, but I must hasten to add that the weeds grow, not in the cotton, but upon the bare fallows that are not under immediate cultivation. One-third only of the land is actually under cotton; this is grown in blocks of about 100 acres, each watering from one of the main canals, and being divided up into 10-feddan plots. The latter are held by the native tenants to whose tender mercies the cotton is entrusted from sowing time to picking. The tenants vary enormously—from energy and keenness to that idle indifference which is so often the cause of English expletives being fluently injected into a sentence of appalling Arabic. If the natives have a keen sense of humour, one must congratulate them upon the perfect solemnity with which they hear their native tongue mangled almost out of recognition; but they are a courteous race, and usually manage to hide their feelings under the cloak of good breeding. Only occasionally do they "go off the deep end" and cast all pride and prudence to the winds. These outbursts are invariably witnessed shortly before pay-day, when the inspector issues to his tenants the orders for their fortnightly loans, and the subject of a few piastres may cause an immediate transformation from dignity to a grovelling humility or to anger. But in the long run they are an easy people to get on with, and easier the more you get to understand them.

Inspectors live, owing to present lack of accommodation, two together in bungalows situated in their particular areas. Behind are the kitchen and stables for two horses, though three horses per man are almost essential. The native pony is a hardy little beast, and seems to thrive under all conditions except when the dreaded horse-sickness is about. One is entirely dependent upon them, and one's work necessitates, of course, riding most of the day, and every day—except on Sundays, that great day when motors invade from all over the countryside, and discharge their loads upon the polo ground.

With regard to one's work, the great thing is that it is essentially of an open-air character, involving much riding. The sun may be hot at times, and the view rather limited in variety, but as the cotton grows one's work and one's vocabulary automatically change and prevent monotony. There is, moreover, a certain romance about this enormous area lately converted from a practical desert to a most productive land, and you feel this during the picking season, when you see the camels plodding slowly along to the ginning factory beneath the burden of two enormous sacks. There is much satisfaction to be gained by working to enlarge one of these drops in the ocean of the world's cotton supply, and especially when it is a British one.

A Day in the Cotton Fields.

It was just about sunrise, the best part of the day, with a nip in the air. The sais brought round my pony, and I started off along the canal to get to my first number (each field is called a number, and all are watered from the same canal). As I rode along, the gephyr came up for any instructions. A gephyr, literally a watchman, has his own beat of a canal stretch, and the numbers (usually three or four) watering from it. He is responsible for maintaining the correct level in the canal, and for opening and shutting his numbers. To-day he volunteered the annoying information that Ahmed Ali in No. 1 had gone to his village the day before, when he ought to have been looking after his water, and as a result his water-channel taking off from the main channel had broken and flooded half his land. Most irritating, this being the time of year when cotton above all things wants a light watering. No. 10 was due; was he to open it ? I would see. Knowing the inveterate idleness of its tenants, I should think it would most probably have to be held up while they picked their cotton clean. Some of them seem to forget entirely that the more they pick the bigger their profits will be, and have to be driven daily to bring in more. How tired you get of some of the continual war-cries: "Pick the cotton," "Pick it like men," "Collect it off the ground." "Taieb hhader" (Certainly, at once) is the inevitable reply, but you wonder how far your words have really sunk.

I got to No. 1, which was watering in the first five hoshas (sectors) each containing its tenant armed with a fork. I was glad to see that they mostly had pickers there picking up the remainder of the cotton from the ground in front of the water. Ahmed Ali's hosha turned out to be a veritable pond, and of course he had attempted to do nothing about it. I let him have it to the best of my Arabic ability, and exacted a 25-piastre fine. It was, moreover, necessary to stop him from taking any more water, and I told him to open all his channels and drain the water to parts yet unwatered. I left him plugging up his irrigation pipe with mud, and grousing because he could not have any more water. They love water, and heaps of it; in fact, if left to themselves I believe they would flood their cotton every time. At the back of the number tenants were beginning to arrive with their pickers collected from stray Tackeruney villages. They always find it difficult to persuade them to turn out early on these cold mornings, and they arrive wrapped up and shivering. One tenant came up bursting with anger and volubility, driving before him a small flock of goats which he had just found eating his cotton, and "not only to-day, but the day before." At this time of year there is a lot of this sort of trouble. I told him to drive them to the bungalow and hand them over to the gardener. There they remain until the owner, full of excuses, arrives to collect them, paying a fine of so much per head.

I cantered along to No. 4, which had been shut three days, and was therefore due to have the remaining water baled out of the main channel. This is a job the tenants loathe, and which they think that only our madness makes necessary; as a matter of fact, it is essential in order to prevent the breeding of mosquitoes. They had most of them got down to it except two notorious wasters, who had not even arrived. I told the gephyr to bring a tulba (working gang) at once. The tulba does the work, and is paid at the tenant's expense. They do not like this a little bit, as, if they did it themselves, it would cost far less, and a tulba is, moreover, a disgrace, except to the more hardened sinners, who after a time take them as a matter of course. At the top of the number the hoshas were already dry enough for the pickers, and each contained about twenty men, women, and children. Having exhorted them to pick it clean and collect it off the ground, I passed on to No. 7. This is a most difficult number to water, owing to its being on rather higher ground, and the smallest elevation makes a great difference. I had already raised the water considerably in the canal by forming a rough sort of weir with stakes, straw, weeds, and rope, and am glad to hear that bags are to be sent along, which can be filled with earth. The number was just finishing, and the pipe was shut so that the last man could take all the drainage water in his last few channels. In the neighbouring fallow most of the tenants were at work on their next year's hoshas—digging drains, removing trees, or levelling uneven places; these things have to be finished before the ploughs come along, which may be at any time.

In No. 10 I found the sheikh, an excellent man to be on the right side of owing to his useful influence with the people of his own village. As I feared, although the number was due for water, there was a vast amount of cotton unpicked, and the ground was almost white with it. I took the sheikh along and showed him, and got him to "strafe" his own folk, which he did roundly. The next day things looked like business, and pickers abounded, and even then it was impossible to give them water without wasting a great deal.

A normal area for an inspector is about twelve numbers, or 1,200 acres, and this means three inspections a day. Moreover, there are sacks to issue at the bungalow. A scribe comes daily and, squatting on the verandah floor, writes the tenant's name and number on each sack. Most days, also, there are miscellaneous chits to give out—for tulbas, for canal work, for work done on next year's land. With one thing and another the day is pretty full, and it is far better so.

COTTON GROWING STATISTICS—II.

COMPILED BY

JOHN A. TODD.

IN this issue the series of tables dealing with the various Empire crops is completed by three tables, containing (1) the British West Indian crops; (2) the smaller Empire crops; and (3) the Indian crop. A table will be included later giving the history of the Egyptian crop, which, although it cannot be included under Empire crops, is obviously necessary to complete the review of the whole position with regard to the supply of fine cotton.

TABLE IV. (*b*): BRITISH WEST INDIES.—In this table the figures of the International Institute of Agriculture at Rome have proved more helpful in providing details of the crops of the various islands, which are not given in the annual reports of the British Cotton Growing Association. The latter only give the totals, which are shown in this table for comparison with those arrived at by the usual method of taking the mean of all the figures available. It will be seen that as a rule the British Cotton Growing Association totals are simply round figures, and only in a few cases—*e.g.*, 1905, 1906, 1909, 1911, 1913, 1920, and 1921—are there substantial differences in the total.

TABLE IV. (*c*): SMALLER EMPIRE CROPS.—Here, again, the figures of the International Institute of Agriculture have been largely used along with those taken from the statistical abstracts of the British Empire and the export figures given by the British Cotton Growing Association. In the case of Cyprus there are also figures given in the *Annual Handbook* published by Comtelburo, and in the case of Australia the official figures of the Department of Agriculture. The figures given in the table are the mean of all these sources, or such of them as are available in each case.

TABLE IV. (*d*): INDIA.—This table gives the history of the total crop since 1899, and will be followed by other tables in subsequent issues giving (1) the details of the crop by States, and (2) details according to different varieties. A comparison of the two columns in this table, which give respectively the total crop according to the Government forecast and the Commercial Crop (Net Exports and Consumption), bears out the statement made in the note on pp. 49-50 of the first issue with regard to the discrepancy between these two sets of estimates. From this it will be seen that the average crop

TABLE IV. (*b*).—EMPIRE COTTON CROPS: BRITISH WEST INDIES.

FOUNDED MAINLY ON THE EXPORT STATISTICS, TOGETHER WITH THE REPORTS OF THE DEPARTMENTS OF AGRICULTURE WHERE AVAILABLE, AND THE INTERNATIONAL INSTITUTE OF AGRICULTURE. THE TOTAL FIGURES OF THE B.C.G.A. ARE ALSO GIVEN FOR COMPARISON.

(*In Bales of* 400 *lbs.*)

Year.	*St. Lucia.*	*Baha-mas.*	*Jamai-ca.*	*St. Vincent.*	*Barba-dos.*	*Grenada.*	*Trini-dad and Tobago.*	*Leeward Islands.*				*Leeward Islands Total.*	*Grand Total.*	*B.C.G.A. Totals.*
								Anti-gua.	*St. Kitts Nevis.*	*Mont-serrat.*	*Virgin Islands.*			
1902	—	3	—	135	—	619	—	.. .. No details				—	757	—
1903	—	17	8	108	1	753	—					148	1,035	1,000
1904	6	21	36	315	480	786	4					290	1,938	2,000
1905	4	17	220	345	861	532	37					982	2,998	4,000
1906	2	33	48	658	1,209	778	28					1,401	4,157	5,500
1907	—	21	16	1,070	2,368	725	28					2,335	6,563	6,500
1908	1	33	51	1,052	2,463	584	34	445	1,148	978	81	2,652	6,870	7,000
1909	15	30	55	875	2,047	809	21	149	1,010	507	131	1,797	5,649	6,400
1910	44	15	33	1,192	1,541	664	28	175	1,010	554	62	1,801	5,318	5,500
1911	10	33	45	1,383	1,825	686	15	279	2,029	1,131	126	3,565	7,562	6,500
1912	12	33	91	1,198	1,073	951	32	245	1,530	882	123	2,783	6,173	6.500
1913	10	34	173	1,214	1,108	1,002	18	462	1,635	730	91	2,918	6,477	7,000
1914	13	—	81	1,085	614	895	—	467	1,842	734	81	3,124	5,812	6,000
1915	8	51	105	920	757	922	—	236	1,844	951	88	3,119	5,882	5,600
1916	—	23	42	706	344	872	20	200	700	700	71	1,671	3,678	3,500
1917	—	10	—	517	156	687	1	85	886	778	37	1,786	3,157	3,000
1918	—	11	—	964	483	604	—	159	1,026	997	46	2,228	4,290	4,500
1919	7	40	9	1,264	285	766	4	404	1,608	1,097	73	3,182	5,557	5,500
1920	11	19	1	1,525	218	937	123	194	1,411	1,358	115	3,078	5,912	4,500
1921	14	—	1	1,286	193	822	—	294	1,935	988	124	3,341	5,657	4,500
1922	1	30	7	801	437	637	—	75	847	905	19	1,846	3,759	4,000
1923	—	—	—	1,206	108	—	—	—	1,311	1,176	—	2,487	3,801	—

TABLE IV. (*c*).—SMALLER EMPIRE CROPS.

(*In 400-lb. Bales.*)

	Cyprus.	*Malta.*	*Australia.*	*Mesopotamia*	*Oceania.*	*Total.*	*Equivalent* 500-*lb.* *Bales.*
1902	1,003	199	—	—	—	1,202	962
1903	888	338	—	—	1	1,227	982
1904	1,101	331	—	—	5	1,437	1,150
1905	1,609	415	—	—	3	2,027	1,622
1906	2,962	425	30	—	1	3,418	2,734
1907	3,801	457	37	—	8	4,303	3,442
1908	3,304	309	24	—	8	3,645	2,916
1909	3,030	514	17	—	—	3,561	2,849
1910	3,765	474	92	—	5	4,336	3,469
1911	5,446	434	122	—	—	6,002	4,802
1912	6,052	839	94	—	—	6,985	5,589
1913	6,042	596	89	—	4	6,731	5,385
1914	5,412	414	17	—	222	6,065	4,852
1915	3,635	379	10	—	590	4,614	3,691
1916	2,498	369	19	—	143	3,029	2,423
1917	2,060	314	75	—	3	2,452	1,962
1918	931	274	100	—	—	1,305	1,044
1919	4,007	309	25	94	—	4,435	3,548
1920	2,357	288	55	114	—	2,814	2,251
1921	1,886	581	705	205	—	3,377	2,702
1922	2,409	660	2,986	547	—	6,602	5,282
1923	—	—	9,794	1,050	—	10,844	8,675

TABLE IV. (*d*).—INDIAN CROP, AREA, YIELD, AND PRICE, 1899–1923.

Seasons.	*Area* (*Acres*).	*Crop* (*Bales of* 400 *Lbs.*)	*Yield per Acre* (*Lbs.*)	*Net Exports and Consumption.*	*Season's Average Price.*	*Per Cent. on American.*
					No.* 1 *Fine Oomra.	
1899–1900	11,885*	2,090*	70	2,106	4·40	90
1900–01	14,231	2,953	83	3,133	4·37	85
1901–02	14,506	2,745	75	3,566	4·19	88
1902–03	16,581	3,367	81	4,050	4·47	82
1903–04	18,025	3,161	70	3,789	5·56	80
1904–05	19,918	3,791	76	3,944	4·62	94
1905–06	20,401	3,416	67	4,168	5·00	84
1906–07	22,488	4,934	88	4,855	4·87	76
1907–08	21,630	3,122	58	3,782	5·03	81
1908–09	19,999	3,692	74	4,200	4·94	90
					Good.	
1909–10	20,545	4,718	92	4,928	6·06	77
1910–11	22,596	3,889	69	4,303	6·78	87
1911–12	21,615	3,288	61	3,985	5·44	90
1912–13	22,028	4,610	84	4,483	5·91	87
1913–14	25,023	5,066	81	5,913	5·62	77
1914–15	24,595	5,209	85	4,889	4·19	80
1915–16	17,746	3,738	84	5,109	5·79	77
1916–17	21,745	4,489	83	4,985	9·92	80
1917–18	25,188	4,000	64	4,499	16·10	74
1918–19	20,997	3,972	76	3,991	17·15	87
1919–20	23,352	5,796	99	5,343	18·05	71
1920–21	21,341	3,601	67	4,941	8·21	69
1921–22	18,451	4,479	97	5,702	8·72	77
1922–23	21,154	5,196	98	6,232	10·25	69
1923–24	22,941	5,042	88	—	—	—

*** 000's omitted.**

for the whole period, according to the Government forecast, was 3,972,000 bales, while that of the commercial crop was 4,454,000 bales, a difference of fully 12 per cent. It is rather striking to find that, in the case of 1919, when the Government forecast shows the high yield per acre of 99 lbs., the commercial crop figure was much lower. But in 1921 and 1922, when again the Government forecast shows a high yield per acre, the commercial crop figures are once more substantially higher.

NOTES ON CURRENT LITERATURE

To facilitate reference, it has been decided to number these articles consecutively. The January number contained 55, of which No. 10 is the article on Seed Cotton Deliveries on p. 60, No. 20 on Germination (p. 69), No. 30 on Weevil-poisoning by Aeroplane (p. 72), No. 40 on the Effect of Humidity and Temperature (p. 75), and No. 50 on Cotton, under Miscellaneous, on p. 77.

Two new headings, " Botany of Cotton and its Allies " and " Co-operation," have been added to the previous list.

COTTON IN INDIA.

56. INDIA AND COTTON SHORTAGE: CROP IMPROVEMENT. (Abstract from *The Times Trade Supplement*, February 2, 1924.)

Mr. B. C. Burt (Secretary, Indian Central Cotton Committee), who was President of the Agricultural Section at the Indian Science Congress at Bangalore, devoted his presidential address to the question of the development of cotton growing in India. He did not agree that India should necessarily produce more cotton irrespective of quality, but pointed out that at present the better qualities have a tendency to compensate for that by lower yield (*cf.* abstract 149). Three means of arriving at an ideal cotton were discussed—isolation of best forms from existing crops, use of acclimatized exotics, and hybridization.

57. THE ANNUAL REPORT OF THE INDIAN CENTRAL COTTON COMMITTEE, BOMBAY, FOR THE YEAR ENDING AUGUST 31, 1923.

The outstanding feature of the year under review has been the passing of the Indian Cotton Cess Act on May 16, 1923, incorporating the Committee as a permanent body with a definite constitution, with funds at its disposal, and with authority to undertake specific work for the improvement of cotton growing.

Under the heading " The Work of the Year " an account is given of the working of the Cotton Transport Act passed in the 1922-23 winter session, by which the transport of cotton in certain specified areas is restricted in order to prevent the importation into superior cotton tracts of inferior cotton for mixing purposes.

During the year the following measures have been drafted:

(i.) A Bill for the regularization of cotton gins and presses, in order to prevent the adulteration of Indian cotton in ginning and pressing factories, and to maintain and improve its quality and reputation.

(ii.) The Bombay (District) Cotton Markets Bill, to provide for the establishment and better regularization of cotton markets.

Various other matters have engaged the serious attention of the Committee, among which may be mentioned the following: The cultivation, picking, and marketing of cotton; co-operative cotton marketing; mixing of Punjab-American cotton; measures to prevent the introduction of the boll weevil into India; the research programme; research studentships.

In addition, details are given in the report of the proposed scheme for a Central Agricultural Research Institute for Cotton at Indore, and of the work to be carried out at the new Technological Institute, Bombay; mention is also made of the decision to proceed with the Sukkur Barrage, on the completion of which it is anticipated that large areas in Sind will be available for cotton cultivation.

The report is furnished with a list of the personnel of the Committee and members of Sub-Committees, and also with several appendices dealing with legislation and other matters connected with cotton cultivation in India.

58. THE BOARD OF AGRICULTURE IN INDIA. (Extracted from the *Agricultural Journal of India*, vol. xviii., part 6, p. 646.)

The thirteenth meeting of the Board of Agriculture in India will be held at Bangalore from January 21 to 26, 1924, when the following subjects, among others, will be discussed:

To consider the steps taken to give effect to the recommendations of the Board of Agriculture of 1919 (Subject IV.) for the improvement of—

(*a*) Forecasts.
(*b*) Final statistics of the area and yield of cotton in India.

To consider the progress made in giving effect to the recommendations of the Indian Cotton Committee for 1917-18 with special reference to—

(*a*) The work of the Central Cotton Committee.
(*b*) The recommendations of the Board of Agriculture of 1919 in regard to cotton marketing.

59. (Extracted from the *International Crop Report and Agricultural Statistics*, January, 1924, p. 8.)

Reports on the cotton crop up to January 11 indicate an average yield in the Punjab, the United Provinces, and in the Central Provinces and Berar, These provinces grow 33 per cent. of India's total crop.

60. From the *Report on the Administration of the Department of Agriculture for the United Provinces of Agra and Oudh* for the year ending June 30. 1923, p. 15, we quote the following:

"*Cotton.*—This crop offers a complex problem. There is no doubt that, as the result of the war, there has been a considerable modification of the class of cotton required by the mills, and especially the local mills. Nevertheless the fact that the crop passes through numerous middlemen's hands between the actual cultivator and the user prevents the increased intrinsic value of a better quality cotton from reaching the cultivator. To the cultivator the hardy high-ginning, short-stapled cottons are still the most remunerative and, in spite of all prognostications to the contrary, the market for such cotton still appears active. Under the circumstances the department can only adopt an expectant attitude. In K 22 there exists a cotton of distinctly superior quality, of which the Raya Farm has become a local centre of production, and for the produce of which in the neighbourhood the local agents are now prepared to pay a premium. Its chief fault is a weakness in germination, which endeavours will be made to overcome. From the Aligarh white-flowered cotton, of which so much ill and good has been said at different times, and of which a severe critic remarked that the fibre lacked the first essential for spinning—namely, two ends—a race with improved lint but with the high ginning percentage and hardy habit of the original stock has been isolated, and will be distributed as seed accumulates. In the central tracts the cultivation of Jn. 1 continues to expand, while, as a result of the cotton survey, several promising races have been isolated. There is thus material available for improvement as soon as economic and trade conditions develop on lines which will ensure the intrinsic value of his produce reaching the cultivator. Such development must be slow, and the department has here to wait on the trade and the work of the recently established Indian Central Cotton Committee."

cotton itself is reduced; and this leads to a less valuable yarn being produced. On emerging from the card the material is in the form of a "sliver"—a continuous rope of fibres which adhere together almost entirely by reason of their natural clinging power after being heavily pressed together by calender rollers. Superior grades of cotton fibres may be subjected to a combing operation; in this case a lap (about 10 inches wide) is prepared from the carded slivers, and through the end of the lap a series of combs of increasing fineness is passed; the combed fringe is removed, the new fringe is combed, removed, and pieced up with the previously combed fringe, and so on, thus giving rise to a sheet of fibres which have been combed. This combed sheet is then condensed to a sliver. By this operation it is possible still further to remove short fibres and neps, and to place the fibres in a very parallel condition in the sliver.

The subsequent treatment of the cotton is very much less drastic. The drawing-frames are used for obtaining more regular slivers in which the fibres are also more parallel than in the carded sliver. Six carded (or combed) slivers are passed between four pairs of weighted rollers; each pair in turn nips the cotton, and by revolving at a faster speed than the previous pair draws out the sliver. The distances between the nips of the various lines of rollers have to be most carefully regulated for the particular cotton being used. The six slivers are in this way each reduced sixfold in cross-section, and are then combined together to form one new sliver having the same dimension of cross-section as each of the original slivers. This operation is repeated a number of times. The next machines—the fly-frames—have as their primary object a reduction of cross-section of the sliver in successive stages; many attempts have been made in recent years to accomplish this reduction in a single stage, but no outstanding, economically successful, method has been widely introduced. The reduction in cross-section is normally effected by the same drafting principle as is employed on the drawing-frames—viz., passing the material between three lines of rollers revolving at increasing surface speeds. For convenience of handling at this stage the material is given a slight twist and is wound on to a bobbin—processes which give rise to complicated mechanical problems, but which should have no harmful effect on the material. The material in the form produced on the first series of fly-frames is known as "slubbing," that from the second (intermediate) series of fly-frames is "intermediate roving," that from the final series of fly-frames is "roving."

The final spinning process consists of a further reduction of the cross-section to the desired amount by three lines of rollers, and then the insertion of the twist to bind the fibres together for strength purposes in the yarn thus formed. As indicated above, there are two methods for inserting the twist—either by the ring-frame or by the mule. The ring-frame takes its name from the flanged steel rings which encircle the (ring) bobbins mounted on spindles revolving at from 8,000 to 10,000 revolutions per minute. On the flange of each steel ring is sprung a small piece of steel wire called a " traveller." As the drawn-out roving emerges from the last line of rollers, it is passed down under the traveller and then led to the bobbin. The revolution of the bobbin creates a tension in the yarn, which drags the traveller round the ring at a slightly lower speed of revolution than that of the bobbin itself; it can be shown that the speed of the traveller, in fact, determines the amount of twist inserted and the rate at which yarn is wound on to the bobbin. On the ring-frame, then, twisting and winding take place simultaneously and continuously. Dragging the traveller round the ring at high speed causes considerable tension in the yarn, especially at the commencement of spinning when the bobbin is empty. It is consequently not ordinarily possible to use this method of spinning for weak yarns. In other words, very fine yarns—which are necessarily comparatively weak—cannot be spun by this method; and other yarns, which are dependent for their strength upon the degree of twist inserted, must be fairly hard-twisted in order that they may withstand the spinning tension. Thus, the ring-spun yarns can neither be very fine yarns nor soft-twisted. The other method of spinning—by the mule—does not labour under these disadvantages. Perhaps the most striking feature of the mule is the to-and-fro motion of a carriage on which are mounted many spindles, inclined somewhat to the vertical, which revolve at from 10,000 to 12,000 revolutions per minute. The roving bobbins are suitably mounted, and the rovings led through three lines of rollers to the spindles. During the outward motion of the carriage there is a corresponding delivery of roving by the front rollers, and the spindles, revolving at a high speed, insert twist; during the inward motion of the carriage the revolution of the spindles causes the winding of the yarn which has been spun on the outward motion. Thus, on the mule, twisting and winding are consecutive, and the whole spinning process is intermittent. The mechanical control is such that the tension during twisting and winding can be regulated to a very fine degree according to the type of yarn being spun. It is therefore possible to spin on the mule yarns having the soft, full character which is desirable for weft;

it is also possible to spin on the mule the comparatively strong harder-twisted yarn necessary for warp.

Some observations may now be made on the relation which exists between the material (*i.e.*, raw cotton) and the spinning processes just described. In the first place, however, emphasis must be laid on the fact that spinning is carried on for financial profit. A spinning plant is laid down for a certain output: the output depends on the counts of yarn spun, and also upon the quality of the raw cotton and of the yarn being spun. Related to these factors are the speed of revolution of the spindles and the speed of the carriage in its outward motion; as this outward motion, when twist is being inserted, occupies about three-quarters of the total time required for a cycle of operations on the mule, it is evident that with a given spindle speed less time is needed when the twist to be inserted is less. Hence soft-twisted yarn can be spun more quickly than hard-twisted yarn; in other words, the output of soft-twisted yarn is greater than that of harder-twisted. Further, coarse yarn requires fewer turns of twist per inch than fine yarn, so that the actual output in *length* of coarse yarn is greater than that of fine yarn; much more, therefore, is the output of coarse yarn greater in *weight*. Exactly the same general considerations apply to the output of a ring-frame. To sum up, if we know the counts of yarn being spun, the number of turns of twist per inch being inserted, and the spindle speed, it is a simple matter to calculate the maximum possible output per spindle; and, if a given total output is required, it is easy to deduce the total number of spindles necessary. It is for such reasons that the size of a mill is commonly indicated by the number of spindles it contains.

For economical working it is necessary that there should be a proper balance between the final spinning machines and all the previous machines. The governing criterion is that the total capacity of any one set of machines must be equal to the total capacity of any other set, with each set working at its full capacity—*i.e.*, the daily output of openers, scutchers, cards, combers, fly-frames, spinning-frames, respectively, must be the same for each. But while this can be arranged at the outset for the production of a definite type of yarn from a definite type of raw cotton, it is evident that any disturbance of either of these has far-reaching effects on the balance which ought to exist between the various machines. Suppose, for example, that an inferior raw cotton has to be used. If the original cotton had been spun to its finest limit—determined practically by the maximum permissible number of breakages during the spinning process—the attempt to spin the inferior cotton to the same limit will result in an excessive number of breakages on the mule or ring-frame, leading not only to a lower quality of yarn, but also to a diminished output and a greater amount of spinning waste. Such a situation is not likely to be satisfactory economically. The difficulty is avoided by not attempting to spin the inferior cotton to the same limit of fineness as the better cotton; instead, a yarn of coarser count is made. But the maximum possible output of the coarser yarn is greater than that of the finer yarn, as explained above. So far as the preparatory machinery is concerned, therefore, one of two things must happen: either it continues to work at its previous capacity, when it will fail to meet the total demands of the spinning-frames; or it must be speeded up so that the spinning-frames shall not be kept idle for want of roving; the latter procedure is that adopted.

Reference has been made above to the fact that some classes of cotton are inferior to others, but nothing was stated as to what is meant by inferiority. Actually this is a most difficult question to answer. It sounds a truism that good cotton is that which gives good yarn. But it obviously does not follow that bad yarn is necessarily the result of using bad cotton, because wrong treatment of good cotton could also give bad yarn. And herein lies the difficulty of making a final judgment as to whether a cotton is good or bad. There are so many processes through which the cotton has to pass that it is impossible to secure with scientific certainty that the settings of the various rollers of the different machines, the weights operating on the rollers, the speeds of the various moving parts, are such as to give the best possible results for the particular cotton used. Subjective error is evidently possible when it has to be left to the judgment of a spinner to decide what these various quantities shall be; in such circumstances fine spinning is akin to a fine art. *Prima facie,* it appears probable that the condition of the material, as it is fed to any given machine of the spinning sequence, will be a factor affecting the quality of the output; and that the best possible yarn will only be obtained from the best possible roving, which in its turn can only be derived from the best possible drawing-frame sliver, and so on. Any deviation from the production of the best possible quality of output from a given machine will entail that the yarn eventually spun is not the best possible. It therefore appears desirable that the quality of the material should be examined at every stage of its passage through the spinning processes in order to isolate the effect of the treatment at each stage. Much work of this kind will be necessary if the spinning test is to be rendered less subjective than it is at present.

Whatever objections may be made to a spinning test, however,

COTTON IN THE EMPIRE (EXCLUDING INDIA).

61. ASIA: CEYLON. *Cotton Growing in Hambantota* (S.E. Ceylon). By F. Burnett. (*Ceylon Observer*, November 23, 1923.)

In a paper read before the Board of Agriculture, Mr. Burnett states that, as a result of the experiments made at Ambalantota Cotton Experiment Station, there has been a growing demand for seed by small cultivators. A scheme was adopted whereby every man applying for two acres (the usual acreage) for chena* cultivation should be given an extra acre at the rent of 1 rupee (1s. 4d.), on condition that it was planted in cotton. Under this scheme 1,649 acres have been taken up, and a supply of American Upland seed has been obtained from South Africa. Heavy rain has interfered with the burning of the chenas, so that the crop will probably not be so good as anticipated. Last year the crop was bought at a guaranteed price by the Department of Agriculture, but this will not be possible with the increased area now planted.

62. *Cotton in Ceylon.* (*Ceylon Observer*, editorial, November 29, 1923.)

The writer urges a determined effort to grow all the cotton possible in the island, suggesting that the time has come for a Government trial on commercial lines through the agency of the Department of Agriculture.

63. *The Budget of the Cooly in Ceylon.*

In view of the importance of knowing all the financial facts that bear upon cotton cultivation, some statistics of the expenditure of coolies in Ceylon, just published by the statistical department of the Ceylon Government (Sessional Paper xxxi. of 1923) are of interest. The typical month's budget of a male cooly, including food, luxuries (areca-nut and betel, tobacco), clothing, cooking utensils, kerosene, matches, etc., is reckoned at Rs. 4.88, or about 6s. 8d. For a family of a man, woman, and two children, the estimated monthly average is Rs. 13.33, or 17s. 9d. The cooly is thus able to save a small sum out of his total possible monthly pay of about £1, and as a rule his wife, and often his children, earn something in addition. He is, of course, usually provided with housing accommodation.

64. IRAQ. (Extracted from the *Monthly Agricultural Bulletin of Iraq* for the period September 16 to October 15, 1923.)

"The total deliveries of cotton at the Baghdad ginnery are 363 tons of seed cotton, of which 85 tons have been ginned. Constant complaints of the severity of the boll worm attack on cotton are being received. On investigation it is found that, in practically all such cases, the low yield of cotton is to be attributed to irregular and insufficient supply of irrigation water during the most critical period, July–August. A pest, recently discovered on hollyhock, which is almost undistinguishable from the pink boll worm of cotton, has been identified as an allied species."

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* A chena is a portion of forest or scrub-forest in which the smaller trees and shrubs are felled and burned. Crops are then cultivated for a couple of years or so on the land thus cleared, and after that time, with the growth of weeds, and the deterioration of the soil, it is no longer profitable, and is once more abandoned to go back to forest (*cf.* Willis, *Agriculture in the Tropics*, pp. 1, 12, 154, *etc.*). A widespread system of cultivation in the East.

65. (*Ditto*, for the period October 14 to November 15, 1923.)

"The total deliveries of cotton at the Baghdad ginnery are 541 tons of seed cotton, equivalent to about 780 bales of 400 lbs. of raw cotton. The cotton crop ceased to yield in the Yusufiyah and Hillah areas towards the end of October; whereas in the Diala and Baghdad Riverain areas the largest pickings of the season are now being collected. The yields of all varieties of cotton grown on the Government farm are appreciably below those of last year. The unusually small demand for the very large stocks of surplus wheat and barley in the country is giving cotton development a decided impetus. All cultivators of cotton in the current season are strongly advised to uproot the cotton stalks as soon as the plants have ceased to yield. This will help to suppress the outbreak of the boll worm pest of cotton in the coming season. The experimental cultivation of cotton on ridges has again given much better results than when grown on the flat. A pleasing feature of the cotton trade in Iraq in the current season is the fact that Messrs. British Cotton Growing Association have decided to increase the price for good quality 'Mesowhite' seed cotton from Rs. 425 to Rs. 500 per ton. This is in marked contrast to wheat and barley prices, which continue to fall. Various cotton exhibits are in course of preparation for the British Empire Exhibition."

66. (*Ditto*, for the period November 16 to December 15, 1923.)

"The cotton crop delivered at the Baghdad ginnery in the current year is equivalent to 1,000 bales of 400 lbs. of raw cotton as compared with 300 bales in 1922 and 60 bales in 1921. A small quantity still remains to be delivered. The relatively high price of Rs. 500 per ton now being paid for seed cotton is likely to effect a considerable increase in the area under cotton next year. Where facilities have continued to be fairly satisfactory throughout the season, the cotton crop continued to yield fairly heavily up to the end of November; but where water for irrigation was found to be inadequate to the needs of the cotton crop, the plants ceased to yield in many cases early in October. In most cotton fields the green vegetation remaining on the plants has been fed off to sheep and the stalks uprooted for firewood. The average yield of sixteen varieties of cotton grown experimentally on the Government farm this year is 1,537 lbs. of seed cotton per acre as compared with 2,110 lbs. last year."

67. AFRICA. (Abstracted from *African Industries*, December 15, 1923, vol. vii., No. 24, p. 397.)

Some encouraging facts as to the progress of cotton production in the British Empire are to hand in the latest communications received from their correspondents overseas by the British Cotton Growing Association.

Sudan.—It was unofficially reported earlier in 1923 that the Sudan crops would be small, with nothing left for export after local consumption had been satisfied, but the Association now states that the season's crop is estimated at 42,500 bales. (And *cf.* **81-2.**)

Uganda.—Uganda is expected to yield the largest crop of Empire-grown cotton, and the latest bulletin from the Agricultural Department indicates that crop prospects are good throughout the Eastern Provinces, and that the loss occasioned by insect pests is slight, and is confined to isolated areas of the early planted cotton; 296,444 acres are under cotton in the Buganda Province, and a large increase in the area planted has been made in Budama and Northern Lango. Prospects in Uganda are reported to be very good as a whole, and a record crop is looked for. (And *cf.* **83-6.**)

Nigeria.—The reports on Nigeria are also most promising, the condition of the crop being better than in any previous year at the same season. Cotton development, however, is hampered by lack of transport facilities, and representations regarding this are being made to the Colonial Office. The Association announces the intention to pay the highest price possible for the new crop when it begins to come in, in order to encourage the native growers. (And *cf.* **69-71.**)

68. Kenya. (Extracted from *African Industries*, December 8, 1923, p. 375.)

"*Cotton.*—The exploitation of the coastal areas for the production from Egyptian types appears to be quite feasible. The lands on the coast which can be irrigated are near the Juba and the Tana Rivers, and in the former case are declared to be equal to about one-third of the cotton lands of Egypt.

"In respect of the coast-land acquisition for the purposes of cultivation, the following official promulgation has been made by the Lands Department: 'With a view to the economic development of the coast area, applications will be entertained at any time for leases of agricultural land within the ten mile coast strip north of Mombasa (formerly part of the Sultan of Zanzibar's dominions) on special terms and conditions, subject nevertheless to the Crown Lands Ordinance, 1915. No stand premium will be charged, but stringent development conditions will be imposed entailing that three-quarters of the total area leased be under cultivation within sixteen years from the date of the lease.

"'In special cases involving large capital different development conditions may be imposed, each case being considered on its merits.

"'The public are particularly warned that they should not make applications unless they are in each case satisfied that taking into account local difficulties as regards labour, etc., they will be in a position to fulfil the conditions under which leases are granted. So far as possible an applicant should apply for a definite area of land in a definite locality, and should enclose a sketch plan in his application, care being taken not to include land privately owned or under dispute in the Land Registration Court.'

"The reference to 'cases involving large capital' prompts the necessary reminder that the coastal areas primarily and pre-eminently appeal to the investment side of *White* colonization; and that as the production is not of the intensive order it demands big capital."

69. Nigeria. *A Note on the Interpretation of the Results of Field Trials as Reported Annually in the Bulletin of the Nigerian Agricultural Department.* By O. T. Faulkner, B.A., Director of Agriculture, Nigeria. (See *Second Annual Bulletin of the Agricultural Department, Nigeria,* July 1, 1923, p. 125.)

A useful discussion of the way in which the results of field experiments, which often show considerable differences, may be statistically handled so as to produce average results upon which more reliance may be placed.

70. (Extracted from the *Second Annual Bulletin of the Agricultural Department,* Nigeria, July 1, 1923, pp. 80, 85, and 91.)

ILORIN AGRICULTURAL STATION (ANNUAL REPORT).

Cotton : Date of Planting Experiment.—The results are as follows:

	Lbs. per Acre.	"*Odds*" *that Difference is Significant.*
Average yield of 18 plots sown September 15	149	—
Average difference:		
4 plots sown August 22 ..	+26·7±17·8	14 : 1
4 " " September 1 ..	+ 9·0±17·8	2 : 1
4 " " September 30 ..	-44·7±17·8	160 : 1
4 " " October 15 ..	-83·7±17·8	Over 100,000 : 1

The original intention was to make July 15 the first sowing date, and September 1 the date for the control plots; but owing to the prolonged drought, which lasted from the middle of June to the middle of August, this arrangement had to be altered.

The yields are decidedly disappointing, as even 250 lbs. per acre, which was the highest yield from any plot, is by no means high; but, on the other hand, they are considerably better than the yields obtained last season.

Most of the cotton produced was badly stained, and only a small proportion was first grade, the actual figures being 330 lbs. first-grade cotton out of a total yield of 2,360 lbs. Much of the cotton produced towards the end of the season was damaged by rain.

Other varieties, newly imported from America, were tested, the best result being given by Lightning Express.

TABLE V.—COST OF CULTIVATION OF COTTON (ILORIN PROVINCE).
(*In "man-days" per acre.*)

Crop.	*Preparation.*	*Sowing.*	*After Cultivation.*	*Harvesting.*	*Miscellaneous.*	*Total.*
Cotton ..	63	7	23	11	3	107

TABLE VI.—RAINFALL, 1922.

	Inches.
January	0·10
February	4·23
March	0·85
April	3·43
May	5·58
June	3·91
July	2·38
August	5·39
September	6·44
October	11·67
November	1·41
December	—

71. *Moor Plantation, Ibadan.* (Abstracted from the *Second Annual Bulletin of the Agricultural Department*, Nigeria, dated July 1, 1923, p. 93.)

During the year 1922 four separate experiments were carried out with cotton, and the yields in the various tests were as follows:

	Experiment.	*Seed Cotton (Lbs. per Acre).*	*Previous Cropping.*
Allen ..	.. Time of planting	26	Maize and ground-nuts in 1921.
Native ..	.. ,, ,,	54	Cotton, 1921.
Maigana Allen	.. Varieties	204 (av.)	Cover crop, 1921.
Zeidabi ..	.. Hills and ridges	123	Partly beans, 1921; previously all grass and bush.

These results were disappointing, inasmuch as up to 1920 400 lbs. of seed cotton per acre had been considered a fair yield and 600 lbs. a good yield, and the crops of the best fields in 1922 were low, and the worst were extremely poor. In all cases the proportion of clean or first-grade cotton was low—usually about 25 per cent.

72. NYASALAND. (Extracted from *African Industries*, December 8, 1923, p. 386.)

In 1920 cotton cultivation had so far advanced after the temporary shortfall caused by the war that it had again attained an acreage of 18,274, a crop of 913,718 lbs., and a value of £86,483, while the tonnage of seed cotton amounted to 288.

Cotton cultivation was introduced into Nyasaland about the year 1900, and in eleven years the acreage had expanded to a total of 23,332, and the corresponding crop in lb. to 1,356,904; but the value of this crop was only at that date £44,099.

73. SOUTH AFRICA. *Cotton Growing under Irrigation: The Pima Variety.* (J. du P. Oosthuizen, in *Journ. Dept. Agr., U.S. Africa*, vol. vii., p. 3.)

The writer points out the advantages of irrigation, even when there is a fair rainfall. Describing experiments at Rustenburg Experiment Station, of which he is the Director, he states that Pima was adopted as against Sakellaridis. This is a variety which arose in fields of Mitafifi cotton in Arizona, and is now largely cultivated there. At Rustenburg, 1,386 lbs. of seed cotton per acre were obtained on a plot of 1¾ acres, while the staple was 1½ inches. Details as to methods of cultivation and harvesting are then given (*cf.* **130**.)

74. *Cotton Growing in South Africa.* (Abstracted from the *British South African Export Gazette*, January, 1924, vol. xxxiii., No. 378, p. 51.)

From this article it is apparent that cotton growing in South Africa is proving at the moment a matter of all-absorbing interest. An account is given of the rapid growth of the industry from the beginning of the war, when the Union was exporting little more than 32,000 lbs., up to the present time, when the figure is estimated to be between 2,000,000 and 2,500,000 lbs.

Much progress has also been achieved in Rhodesia and Mozambique. In Southern Rhodesia a scheme is on foot for the erection at Salisbury of a ginnery, and an extensive area is to be experimentally planted with cotton this year.

It is estimated by Mr. G. F. Keatinge, C.I.E., in his report to the Empire Cotton Growing Corporation, that South Africa can probably produce a total of 500,000 bales, half of which should be attainable in the next twenty years. The areas considered by him most suitable for cotton cultivation are the low-lying lands between the Drakensberg and Lebombo Mountains running from Zoutpansberg in the Northern Transvaal southward to Zululand, and the Rustenburg and Waterberg districts.

The writer disposes of the belief entertained by some enthusiasts that South Africa may become a rival of America as a supplier of cotton by stating that America possesses an acreage of 20,000,000 as against South Africa's 4,000,000 acres, but it is considered that a profitable industry can be built up while the world's demand continues to increase as at present, the more so as it is anticipated that production costs can be kept considerably lower than in America.

In conclusion, it is urged that immediate attention be given to the following matters if success is to attend the efforts to establish the cotton-growing industry in the Union:

(i.) Seed selection.
(ii.) Standardization of the staple, in order to meet Lancashire's requirements.
(iii.) Erection of central ginneries.
(iv.) Organization of the export trade on a sound basis.
(v.) Provision of infinitely better communications.

In connection with the latter, it is gratifying to note that Parliamentary sanction is to be obtained next session for the construction of a new railway line from Somkele to the Pongola, thus giving a very promising Zululand district priority.

An interesting fact is mentioned in the last paragraph of the article: the writer states that cloths have already been made from South African cotton which compare favourably with any on the market, and the first large shipments have been made to the Cape through the enterprise of Messrs. Stuttaford and Co., Ltd.

75. *Cotton in South Africa.* (Abstracted from the *Journal of the Department of Agriculture* for the year ended June 30, 1923, vol. vii., No. 6, p. 563.)

The Chief, Tobacco and Cotton Division, states in this report that widespread interest in cotton production is being taken in the Union, and that if present prices continue for a few years there is every prospect of a rapid development of the industry. The cotton crop for 1922-23 will show a considerable increase over that of any previous season.

The Cotton Exchange was unable to function to its fullest extent owing to shortage of funds and the lack of confidence of cotton growers, but if full advantage were taken of its offices to concentrate larger consignments of each grade of cotton, better results could be expected.

There has been a great demand for good cotton seed, and all the seed from the 50 acres planted to cotton at Rustenburg last season was readily sold. The crop produced at the station on preliminary grading averaged 1$\frac{3}{16}$ inches, and shows great improvement in the quality of the cotton.

Experiments on cotton have been carried out along the following lines: selection of types for seed, testing individual plants in comparative row trials, testing different distances of planting, irrigating long staple cotton, improvement of commercial fields by elimination of poor plants.

The fertilizer and rotation experiments at Rustenburg gave excellent results. The students' hostel at this station was full. Prospective farmers constantly urge the need of a year's special training in cotton culture, and unless further facilities are provided for this training many deserving applicants will have to be refused.

The cotton grader visited ginneries to classify seed cotton, and later graded samples of all bales of lint produced in the Union; 1,719 bales of approximately 500 lbs. each were dealt with by the grader and the Durban officer, and they also graded and reported on a great many small samples of cotton seed sent in by farmers.

76. (Abstracted from the *Journal of the Department of Agriculture* for the year ended June 30, 1923, vol. vii., No. 6, p. 549.)

"Importations of cotton seed are very severely restricted; most applications for permits are refused. Four lots of cotton, aggregating 983 lbs., were admitted, the chief importation being a lot of 900 lbs. of Pima variety for the Department of Agriculture."

77. *The Cotton Industry.* (Extracted from the *Journal of the Department of Agriculture*, South Africa, for year ended June 30, 1923, vol. vii., No. 6, p. 489.)

The potentialities of the cotton industry in South Africa are regarded as enormous, and there is every sign of a rapid expansion taking place in the very near future. The crop of 1922 was somewhat less than that of the previous year, but the crop for 1923 will show a considerable increase over any previous season. Great and widespread interest is being shown in cotton production, and practical interest of a very real form has been shown by the Empire Cotton Growing Corporation, which has offered to defray the salaries of three specially qualified officers, whose services it is prepared to loan to the Government for developing the industry in South Africa. This offer has been gratefully accepted.

The Cotton Exchange, a co-operative organization of cotton growers, has not been able to function fully owing to the lack of unanimity among growers as to its advantages, but recent indications point to a fuller measure of support in the near future.

The grading system referred to in last year's report has been brought into operation, and during the year 1,719 bales, of approximately 500 lbs. weight each, were dealt with.

A levy on export cotton was also imposed. The funds realized will be applied to the improvement of the industry in such manner as may be decided by the Minister in consultation with representatives of the industry. The amount realized from the levy, which is at the rate of 1s. per 100 lbs. lint, was £230, being for the months of May and June, 1923. The fee for grading is 1s. per bale.

It is very evident that steps must be taken betimes if the work of the division is to keep pace with the expansion of the industry, and this matter is receiving careful consideration. The question of improvement of seed is also one which is being dealt with in this connection.

78. *Matabeleland Cotton.* (Extracted from *African Industries,* December 22, 1923, vol. vii., No. 25, p. 417.)

Mail advices state that the Secretaries to the Cotton Growers Association of Matabeleland have received commendation from Mr. H. W. Taylor, the Government cotton expert, Salisbury, of much of their areas as excellent for cotton growing; and he expresses the opinion that "with favourable climatic conditions this crop will undoubtedly thrive in several districts of Matabeleland." Mr. Taylor visited in all thirty-three farms within a radius of about thirty miles of Bulawayo.

79. *Swaziland.* (Extracted from the *Report for* 1922, *Swaziland,* No. 1180, pp. 5 and 7.)

The exports of cotton from Swaziland during the last three years, and their value, are as follows:

	Quantities in Lbs.			*Value.*		
	1920.	1921.	1922.	1920.	1921.	1922.
Cotton ..	411,350	274,400	142,148	£10,282	£6,860	£2,013

Cotton is becoming a more important crop each year. Owing, however, to the low price early in 1922, the area under cultivation was small. The cotton market has shown a considerable improvement, and larger areas are now being grown. The interest shown by the various Administrations in South Africa and by the Empire Cotton Growing Corporation, and the steady demand for land suitable for cotton growing, as well as the encouraging results obtained both here and elsewhere in South Africa, are stimulating the growing of cotton. Most of the cotton sown was of the "Griffin" and "Watts' Long Staple" varieties, from seed produced by the farmers from seed imported by the Administration during the previous year. It is hoped that after two or three years this seed will establish a first-class acclimatized and uniform cotton.

Other varieties grown in smaller areas were "Improved Bancroft" and "Zululand Hybrid." It has yet to be proved which will be the most suitable seed to be grown to produce a uniform cotton of good quality. A cotton gin is now available at Bremersdorp. The area under cotton during 1922 was about 170 morgen (or approximately 350 acres).

80. *Transvaal.* (Extracted from the *Queensland Agricultural Journal,* December 1923, vol. xx., part 6, p. 459.)

"*Cotton Research and Teaching Institute in the Transvaal.*—The Transvaal University proposes to found an Institute for Cotton Research to work in collaboration with the Department of Agriculture, Tobacco and Cotton Division. Amongst other questions studied there will be the control of the plant and animal parasites of cotton, the formation of standards, the length and tenacity of the lint, the spinning quality of South African cotton, and the general development of the cotton industry."

81. SUDAN. (Extracted from the *Annual Report of the Director, Commercial Intelligence Branch, Central Economic Board, Sudan Government,* 1922-23.)

Two events make the year 1922 stand out as an especially noteworthy one:

1. After a temporary stoppage owing to insufficiency of funds, work was resumed last autumn on the Makwar Dam on the Blue Nile near Sennar and the Gezira Canalization Scheme. The resumption of work on this project, which is of such vital importance to the Sudan, was rendered possible by an undertaking by the Imperial Government to guarantee the principal and interest of a further loan sufficient to raise a sum of £E3,500,000 to meet expenditure on these developments.

A contract for the carrying out of these works was placed in September, 1922, with Messrs. S. Pearson and Son, Ltd., and they are under obligation to complete in time for the irrigation of the 1925-26 crops.

The canalization is designed for the annual cultivation by free flow irrigation of an initial area of 100,000 feddans of cotton, estimated to give a yield of 80,000 to 100,000 bales of lint. Sufficient water can be held up by the dam to command a much larger area than 100,000 feddans.

This great cotton-growing scheme is to be carried on in co-partnership on a profit-sharing basis between the Sudan Government, the native cultivator, and the Sudan Plantations Syndicate. In order to accustom the native to cotton cultivation by up-to-date methods, large areas have already been developed under cotton by means of pump irrigation in the district comprised in the scheme, and have produced most successful results. When the new pumping installation at Wad El Nau comes into operation this summer, it is expected that some 20,000 feddans will be cultivated with cotton this season in the area to be irrigated by the dam.

The substitution of an assured water-supply for the vagaries of an unreliable rainfall, and the steady production year by year of large quantities of a valuable and readily saleable commodity such as cotton, will revolutionize conditions in the Gezira, and will profoundly affect the whole of the northern and central parts of the country, and in many ways the scheme will make its influence felt in regions much further afield. Moreover, the annual migration of labour to and from other parts of the Sudan into the Gezira for the seasonal occupation of hoeing and picking cotton will tend to distribute the proceeds of the sale of the cotton amongst the population generally, and will stimulate trade in many districts far removed from the cotton area.

2. A still further insurance against the risks attendant on the vicissitudes of an unreliable rainfall will be afforded by the opening up of the Eastern Sudan by the Kassala Railway, the commencement of which has been the other great outstanding event of the year.

The funds for the construction of the railway have been raised under a guarantee by the Imperial Government as to principal and interest under the provisions of the Trade Facilities Act of 1921.

The railway will be built and operated by the Sudan Government Railway Department under contract with the Kassala Railway Company, and will eventually become the property of the Sudan Government. It will run from near Thamiam, about 124 miles from Port Sudan on the Nile-Red Sea Railway, to Kassala in the Eastern Sudan, a distance of about 217 miles. Kassala stands near the head of the large delta formed by the annual overflow of the inland River Gash.

The linking up of Kassala and the eastern districts of the Sudan with the sea will afford an outlet for the valuable produce obtainable in this part of the country.

It is estimated that the Gash Delta, when fully developed, will be capable of producing, with relatively little expense on irrigation works, at least 100,000 bales of good Egyptian cotton per annum, but without a railway it has been impossible to undertake the cultivation of cotton on any appreciable scale. The first purpose of the railway, then, is to enable this large area to be put as rapidly as possible under cotton. This development will be undertaken by the Kassala Cotton Company, which is closely allied to the Sudan Plantations Syndicate, on a sharing system between the company, the native cultivator, and the Government, somewhat similar to that employed in the Gezira.

The building of this new railway should also lead to an increase in the cultivation of rain-grown cotton on the fertile rainlands of the southern districts of Kassala Province.

The report goes on to say that, although there is sufficient labour in the country for the various development schemes in course of being undertaken, it is of the greatest importance that such labour as there is should be actively productive. The population is roughly estimated as 5,852,000.

It is also stated that substantial reductions of railway rates have been made on cotton (unginned to ginning factories).

82. In Appendix XXI. on p. 97 of the Director's *Annual Report* for 1922-23 of the Central Economic Board, Sudan Government, is given a table of rainfall statistics (in millimetres) for various stations in the Sudan, which show what is perhaps an unusual degree of variability; for example, Singa, Khartoum, Kassala.

The question of rainfall distribution will evidently be one of some importance in cotton cultivation in the Sudan, and it is to be regretted that the figures only cover three years as yet.

83. UGANDA.—From *African Industries* of December 8, 1923, p. 374, we quote the following as indicating the efforts that are being made to encourage cotton production in the Protectorate:

"In Uganda cotton is almost to be regarded as a matter of high policy, which is based upon the following principles: (*a*) To increase the production of cotton in every part of the country where there is a reasonable hope that the crop can be sold; (*b*) to improve the quality of the cotton produced, and to increase the yield per acre; (*c*) to ensure that an increased area under cotton gives a corresponding increase in food production by a suitable rotation of crops; (*d*) to bring the cotton grower and the actual cotton ginner, as far as practicable, into direct contact; (*e*) to keep down cotton pests and diseases by the enforcement of regulations.

"In order to encourage production, with a reasonable hope that the crop can be sold, cotton has been placed outside the category of ordinary native crops such as ground-nuts and chillies, and rules made regulating the purchase and sale of the crop. In this way it has been possible to a great extent to bring the actual grower of the cotton and the ginner into direct contact.

"The Eastern Province is the largest producing area, and owing to shortage of staff, etc., it has been necessary to concentrate on that area for cotton production. The number of cotton markets has been gradually reduced, until now the sales of cotton in the Eastern Province are confined to sixty-three ginneries and thirty-two markets."

84. (Extracted from the *Report for* 1922, *Uganda,* No. 1182, p. 8.)

Cotton.—The total value of domestic produce exported from the Protectorate during the year amounted to £1,215,793, as compared with £1,539,538 for the preceding twelve months. The value of ginned cotton exported amounted to £877,625, more than 72 per cent. of the total for the entire outward trade. As a consequence of the low prices obtaining during the 1921 cotton-buying season a smaller acreage was planted in that year, with the result that the value of cotton exported during the year under review was over £400,000 less than the amount for 1921. Under the scheme of Government buying which was introduced on account of the difficulty experienced in disposing of the 1921 crop, the Agricultural Department purchased 4,779,735 lbs. of seed cotton; the total expenditure involved was £45,805, and a net profit of £30,721 was realized by the sales. The total acreage under cotton in 1922 was estimated at 333,600 acres—more than twice the area planted in 1921. The principal cotton area is the Eastern Province, where it is estimated that 250,600 acres are under cultivation. During the year 17,919,300 lbs. of cotton were exported to India, as compared with 19,120,790 during 1921. The proceeds derived from the cotton duty, a tax of 6 cents per lb., amounted to £64,034. The use of tractor ploughs in the Siroko Valley had the effect of attracting natives from the Bugishu Hills to grow cotton on the land ploughed, and the area is being extended further with a view of encouraging more Bagishu to take up land for ploughing.

85. (Extracted from the *Journal of the Textile Institute,* November, 1923, vol. xiv., No. 11, p. 296.)

"*Uganda and Tanganyika Cotton.*—Reports from all districts in Uganda show that if the weather conditions continue favourable, a record cotton crop may be expected next year. At a recent Kampala Cotton Conference held at the suggestion of the Governor of Uganda, many important problems in connection with the industry were freely discussed, and a practical decision arrived at concerning the improvement of roads over which cotton has to be transported. In all, about £120,000 will be spent on road making and maintenance shortly, and this, combined with the outline of the Government's policy as regards the industry given by the Director of Agriculture, has certainly stimulated trade conditions generally throughout the territory."

86. (Extracted from *African Industries,* January 5, 1924, vol. viii., No. 1, p. 7.)

His Excellency Sir Geoffrey Archer, in opening the great Uganda Agricultural Show, drew particular attention to the cotton and coffee exhibits, which he regarded as of special interest. He pointed out that the last time the show was held, in 1908, the annual value of the Protectorate's output of cotton was less than £15,000, whilst for the first nine months of 1923 the value exceeded £1,750,000.

87. AUSTRALIA. — In connection with cotton growing in Australia, a monthly bulletin entitled the *Australian Cotton Grower* is published by the British Australian Cotton Association, Ltd. The magazine is illustrated, and gives useful information on matters connected with the cultivation of cotton in the Commonwealth. It can be obtained from the Motor Press of Australia, Ltd., 16, Pitt Street, Sydney, New South Wales, at a cost of 6d. a copy, or at an annual subscription of 5s., including postage.

88. *Cotton as a Subsidiary Crop to Fruit.* An editorial in the *Australian Cotton Grower* for September, 1923, recommends, in view of the over-production of fruit and the glutted state of the market, that growers should replace part of their fruit areas with cotton, which suits the climate equally well.

89. (Abstracted from the *Farmer and Settler*, Sydney, December 14, 1923.)

The British Australian Cotton Association, Ltd., estimates that a total of 100,000 acres will be planted to cotton in Australia this season. With an estimated yield of 480 lbs. to the acre, a net return of 48,000,000 lbs. may be expected; should the crop, however, yield at the rate of 600 lbs. an acre, as has been the case for the five years preceding 1923, this return will be exceeded.

A charge of ½d. per lb. for seed has been imposed in order to ensure that applications may be more in conformity with actual planting; last year many settlers sent in applications for seed irrespective of their planting prospects.

90. *Australian Cotton Picker.* (*Herald*, Melbourne, September 6. Abstract from the *Textile Recorder*, January 15, 1924, vol. xli., No. 490, p. 57.)

We give the following details regarding an automatic cotton picker which, according to report, has recently been invented in Melbourne: The machine is portable, is 17 feet high and 4 feet in diameter, and consists of a circular tower carrying two horizontal arms having a 35-foot spread and a width of 8 feet with a series of holes on the under side. The cotton is drawn into the hollow arms by suction, and carried to a central chute, where it is compressed into bales and dropped out of the machine. An 8 h.p. engine is used, and the total weight of the machine is about 1,500 lbs.

91. NORTHERN TERRITORY OF AUSTRALIA. *Report on the Cotton-Growing Possibilities of the Northern Territory of Australia.* By G. Evans, Director of Cotton Culture, Queensland.

A report of a tour undertaken in July and August, 1923. Mr. Evans states that the climate seems to resemble that of the Deccan and Central Provinces in India, and the country appears suitable; but in view of the fact that the whole population is only a few thousands it is evident that little or nothing can be done with cotton at present, and he recommends the trial of experiments in selected localities and the establishment of a small ginnery at Darwin.

92. NEW SOUTH WALES. *Conditions Favourable to Cotton Culture: Climates and Soils in New South Wales.* By H. Wenholz, B.Sc.Agr., Special Agricultural Instructor, and E. S. Clayton, Agricultural Instructor. (Abstracted from the *Agricultural Gazette of New South Wales*, September, 1923, vol. xxxiv., part 9, pp. 665-668.)

In this article the authors describe the climatic conditions necessary for the profitable production of cotton in New South Wales, which may be summarized as follows: A relatively high temperature, a long growing season with a large amount of sunshine, a moderate and well-distributed rainfall, especially during the growing season, and a relatively small amount of rain during the picking season.

The most suitable soils for growing cotton, and those from which the best yields are usually obtained, are fertile, well-drained, alluvial, or good volcanic soils, but in some districts payable crops are grown on soil of only moderate fertility. On poorer soils, with good rainfall, fertilizers will probably be necessary to ensure a paying crop. The following districts in New South Wales have already yielded profitable crops:

The Upper Richmond River district, from about Casino northwards.
The Clarence River district, especially the upper portions from about Grafton to Tabulam, with the possible exception of the lower Clarence.
The Hunter Valley (alluvial soils in districts of good rainfall).

Other districts are mentioned where cotton may possibly be grown successfully, but further experiments will be necessary in order to demonstrate the profitableness or otherwise of the crop.

93. ***Establishing the Cotton Industry in New South Wales.*** **(Abstracted from the *Textile Recorder*, December 15, 1923, vol. xli., No. 489, pp. 119, 121.)**

Mr. Chaffey, the Minister for Agriculture, New South Wales, has supplied the following information in response to many enquiries received from prospective cotton planters regarding the cultivation and marketing of cotton:

The New South Wales Government has given a guaranteed price to growers for three years for cotton delivered at the ginnery at the following rates:

1923-24: 5½d. per lb.
1924-25: 5d. per lb. for 1¼ inches staple, 4½d. for ¾ to 1¼ inches staple.
1925-26: 4½d. per lb. for 1¼ inches staple, 4d. for ¾ to 1¼ inches staple.

The Government has undertaken to gin, ship, and market the cotton, any profits derived from the sales to be returned to the growers after deducting all expenses. To ensure that ginneries will be available for the removal of the seed and preparation of the cotton for market, the Government have entered into an agreement with the British Australian Cotton Association, Ltd., for three years, and during that time will pay them 1¼d. per lb. for all cotton lint prepared by them. It is also agreed that a ginnery shall be established in any district where 7,000 acres are sown with cotton.

The assistance rendered by the Government has resulted in a fairly considerable acreage being placed under cotton. The abnormal drought of last season adversely affected all crops, but the quality of the cotton was, considering all the circumstances, very satisfactory, and it is hoped that in normal seasons high yields of good quality cotton will be obtained. Cotton can be grown successfully on suitable soils of the north coast, and will probably be profitable in many districts of the north-western part of the State, such as Inverell, Tamworth, Narrabri, etc. It is anticipated that from 15,000 to 20,000 acres will be planted with cotton this year. Cotton seed will be supplied by the Australian Cotton Association at a nominal charge of ½d. per lb. to cover cost of bags, freight, etc.

On application to the State Department of Agriculture intending cotton planters can obtain gratis information on the following subjects: The most suitable varieties of cotton to plant; methods of cultivation; cotton pests and diseases, and the measures necessary for their control.

The Department also state that a more extensive publication on the subject of cotton cultivation will be available shortly at a very small cost.

94. *The Cotton Crop: Cultural Advice for New South Wales.* By H. A. E. McDonald, Chief Inspector of Agriculture. (Obtainable from the Government Printer, Alfred J. Kent, Sydney, New South Wales.)

A handy manual of elementary information about cultivation.

95. QUEENSLAND. (Extracted from the *Queensland Agricultural Journal*, September, 1923, vol. xx., part 3, p. 239.)

The *Queensland Agricultural Journal* for September contains an excellent and well-illustrated elementary paper on cotton cultivation by W. G. Wells, Cotton Specialist, from which we extract the following notes that are of more than merely local application:

"*Cotton Cultivation in Queensland.*—Ever since 1858 there have been spasmodic attempts to develop a cotton-growing industry in Australia, and particularly in Queensland, but with the exception of a short period when a total area of 14,000 acres was developed in about 1870, it cannot be said that the industry has flourished to any marked degree until within the last few years.

"In 1919, owing to the growing scarcity of cotton, the Government of

Queensland determined to make an extreme effort to put the cotton-growing industry in this State on a permanent basis, and in order to accomplish this aim guaranteed to the growers a price of 5½d. per lb. for all seed cotton of good quality.

"*The Necessity for Pure Strains of Varieties of Cotton.*—The Department of Agriculture and Stock realizes the necessity of developing the cotton-growing industry on lines based on the production of only the highest quality of uniform pure varieties of cotton of the types which are in demand by the fine spinners of the world. Pure varieties of these types have been introduced from the United States, and experiment stations are being developed where these varieties can be carefully selected and bred to suit the requirements of the various sections of the cotton-growing districts.

"The experiences of the other cotton-growing countries of the world, particularly in Egypt and in the United States, show the absolute necessity of placing a cotton-growing industry on a one or 'community' variety basis. This is not only of advantage in maintaining the purity of any cotton which may be found the most suitable to the various climatic and soil conditions of a country, but is also of marked assistance in the marketing of the crop to its fullest value.

"Localities which grow only the one type of uniform cotton year after year soon become known to the cotton trade for their reliability of types, and the buyers are willing to even pay premiums over the average market in order to secure such uniform cottons.

"*The Necessity for Clean Picking of the Crop.*—The demand of the cotton-spinning industry of to-day is good, clean cotton, and the growers of Queensland should endeavour to forward only this grade of cotton to the ginneries. Freedom from leaf, grass, grass and weed seeds, immaturity, dirt, excessive stains, water or excessive moisture, disease, and all foreign matters, is necessary in order to produce a high grade of lint.

"Wet cotton should be particularly guarded against, as it is exceedingly difficult, even if the cotton is free of leaf or foreign matter, to gin a good sample of wet cotton, on account of the fibres matting together when being ginned. This is very objectionable from the spinners' view-point, as such cotton contains a high percentage of waste.

"There is no objection to picking cotton before the morning dew dries, but such cotton should be spread out in the sunlight on a clean waggon sheet or on the verandah, and stirred several times during the day to ensure proper drying.

"Grass and weed seeds are very difficult to remove from lint cotton, and the grower should endeavour to keep the fields free from such during the picking season. Cotton left in the boll until the winds blow it out straggly is often subject to this trouble, and the grower is cautioned not to allow his crop to remain unpicked for too long a period of time. Not only is this inadvisable on account of collecting foreign matter, but there is a danger of non-seasonable storms occurring, which cause a loss to the crop through part of it being beaten to the ground or being stained; also cotton which is left for too long a period of time in the sunlight loses some of its bloom and character, with a consequent resulting loss in value.

"Particular care should be exercised to not pick the small, hard, unopened locks of cotton. The fibres in these locks are weak and of light body, and when mixed with good lint lower the value of the sample, as the weak, light-bodied fibres are combed out in the mills as waste."

Much information regarding cotton cultivation, etc., is also given by the author under the following headings: Advantages of growing cotton; types of soil suitable for cultivation; preparation of the seed bed; time to plant; methods of planting; scrub planting; spacing between rows; proper time for thinning;

how to thin; distance to thin; cultivation; when to pick; picking receptacles; methods of forwarding cotton to the gins; necessity for grading.

The terms of the Government guarantee are also detailed.

There are several illustrations in the paper depicting various stages of cotton development, cotton damaged by insect pests, drying and packing cotton for despatch to the ginnery, etc.

96. (Extracted from the *Queensland Agricultural Journal*, December, 1923, vol. xx., part 6, p. 396.)

"The Director of Agriculture, Mr. H. C. Quodling, commenting in his report upon the indifferent year from an agricultural point of view, makes a strong comparison in favour of a cotton crop as a great revenue producer in dry seasons, and mentions the natural ability of the cotton plant, not only to live, but to produce a crop, as being in marked contrast to the maize plant, which has suffered so severely in the southern and central districts. The moral of the experience is, therefore, that no farmer in the districts where cotton can be grown within a payable distance of a ginnery should make his arrangements for the year without including a field of cotton."

97. *Report on the Cotton-Growing Prospects in the Maranoa District and the Area South-West of the Main Range, Queensland.* By G. Evans, Director of Cotton Culture, Queensland.

In this report of a tour undertaken in September, 1923, Mr. Evans gives a favourable account of the region traversed, which lies a comparatively short distance to the south-west of Brisbane. There appears to be a prospect of perhaps 25,000 to 30,000 acres being planted in cotton this season. Mr. Evans thinks that perhaps too much reliance has been placed upon wheat, and that a second crop, like cotton, introduced into the farming system, will be a good thing. Individual farmers are not expected to be able to manage more than 20 to 30 acres of cotton.

98. *Irrigation in Queensland* (cf. *Empire Cotton Growing Review*, January, 1924, vol. i., No. 1, p. 70) is being continued in each monthly issue of the *Queensland Agricultural Journal.*

99. WESTERN AUSTRALIA. (Abstracted from the *West Australian*, Perth, December 20, 1923.)

On December 19, 23 bales of seed cotton and 2 bales of cotton lint were shipped by the s.s. *Persic* to the British Australian Cotton Association, Liverpool. This consignment is destined for the British Empire Exhibition, partly for display in the Australian Court, and partly for exhibit by the Empire Cotton Growing Corporation on their stand representing the cotton resources of the Empire.

It may be added that this shipment is virtually the first export of cotton.

100. WEST INDIES: MONTSERRAT. *Cotton Experiments.* (Abstracted from the *Report on the Agricultural Department, Montserrat*, 1921-22, p. 3.)

The preliminary paragraphs deal briefly with the experiments conducted on the strain of cotton known as H. 23-2-13 during the year 1920. The results obtained in that year were unsatisfactory, owing to the low rainfall experienced during the earlier period of the growth of the cotton plants.

A detailed account is given of the cotton breeding work done in 1921, the year under review, but again the low rainfall proved a limiting factor in the achievement of satisfactory results. It is of interest to note, however, that although the cotton breeding experiments of 1920 and 1921 were considered to have been adversely affected by the unfavourable weather, the results for 1921 showed an obvious improvement in the factory seed cotton per boll, lint per boll, loculi value, and size of bolls over the figures of 1920.

A summary is given below of the average results from the H. 23-2-13 strain of cotton on the breeding plot since 1919, the first year of its cultivation, with the average results from the reselections grown in 1920 and 1921.

AVERAGE RESULTS FROM H. 23-2-13 STRAIN FOR THREE YEARS.

Year.	*Seed Cotton per Acre.*	*Per Cent. Lint.*	*Lint per Acre.*	*Seed Cotton per Boll.*	*Lint per Boll.*	*Lint Length.*	*Seed Weight.*	*Lint Index.*	*Loculi per Boll.*	*Bolls per Lb. Seed Cotton.*
	Lbs.		Lbs.	Grms.	Grms.	Mm.	Grms.	Grms.		
1919	3,221	28·6	921	3·58	1·05	49·6	14·46	6·04	3·5	128
1920	2,382	29·2	711	3·84	1·12	48·0	13·56	5·60	3·5	119
1921	2,445	29·2	679	4·05	1·18	49·6	14·10	5·83	3·5	112

101. (Extracted from the *International Crop Report and Agricultural Statistics*, November, 1923, p. 501.)

Cotton picking began in July. The crop was expected to be small owing to insufficient rainfall during the period of growth, but the second flowering is plentiful, and favourable weather in October may improve results. The pink boll worm is general, but good yields are reported even from fields which have been severely attacked.

102. ST. VINCENT. *Cotton Crops.* (Extracted from the *West India Committee Circular*, January 3, 1924, vol. xxxix., No. 659, p. 16.)

A favourable crop is reported for this year, and the yield per acre is expected to exceed that of last year. The Agricultural Department Report for 1922 states that the Government cotton ginnery, in addition to ginning 1,174,101 lbs. of cotton seed, expressed 733,570 lbs. and disintegrated 83,013 lbs.

103. (Extracted from the *International Crop Report and Agricultural Statistics*, January, 1924, p. 8.)

On the whole the cotton crop, chiefly Sea Island, was of good promise at November 15. Good weather has been experienced, and the material damage done by disease and insect pests is not great.

104. TRINIDAD.—The Agricultural College—now the Imperial College of Tropical Agriculture—in Trinidad was opened in October of last year for the purpose of giving a thorough training in tropical agriculture to students intending to become tropical planters, investigators, or experts in different branches of agricultural science or technology. Accommodation is also provided for graduates of other institutions to conduct research work in connection with tropical agricultural problems. The Empire Cotton Growing Corporation are of opinion that the college will provide an opportunity whereby officers selected for service in cotton-growing countries may receive that training in general tropical agriculture which is so essential to them before taking up their duties. It is recognized that cotton growing is one of a series of farming operations, and can only be successfully conducted if those responsible have received a sound training in the general principles of agriculture and agricultural rotations as conducted in the tropics, in addition to special instruction relating to cotton itself. At the West Indian Agricultural College facilities will be available for providing such training, and special attention is also to be given to instruction on the administrative side of official agricultural work. On these grounds the Corporation have agreed to contribute £500 a year for two years to the funds of the college. The Director of the Corporation has been co-opted as the Corporation's representative upon the governing body of the college, and men sent out by the Corporation for special training, or to do advanced post-graduate work, will be received in limited numbers without payment of fees.

105. *The Imperial College of Tropical Agriculture, Trinidad.*—From the *West India Committee Circular* of January 31, 1924, vol. xxxix., No. 661, p. 41, we give the following information regarding the students in training at the college:

Four post-graduate students, nominated by the Empire Cotton Growing Corporation for special training in genetics and plant breeding, have recently been on a tour through the cotton-growing islands of the West Indies in order to gain an insight into the experimental and plantation work being carried out in connection with the industry. Eighteen students are taking the Diploma course. Two former students have received appointments in Nyasaland, while a third is an overseer at the Usine St. Madeleine.

COTTON IN THE UNITED STATES.

106. COTTON PRODUCTION AND CO-OPERATION. By A. H. Stone, Vice-President, Staple Cotton Co-operative Association. (Abstracted from the *Agricultural Journal of India*, vol. xviii., part 6, pp. 639-645.)

In this paper the author gives an account of the methods of handling and distributing cotton which have been in operation since the early part of the nineteenth century. He explains the "factorage" system and its resultant evils, and brings the history up to the year 1900, when railroads rendered possible some improvement in the method of marketing—*e.g.*, local buyers established themselves in every small town, local banks were organized, and local compresses and warehouses were built. The necessity for further remedial measures became apparent, however, about the year 1920, and this led to the formation of the Staple Cotton Co-operative Association. The paper concludes with a detailed account of the personnel, and of the successful operations of this Association.

107. COMPULSORY COTTON STANDARDS IN THE U.S. UNDER THE NEW COTTON STANDARDS ACT. (*International Cotton Bulletin*, No. 3, 1923. Abstracted from the *Agricultural Journal of India*, January, 1924, vol. xix., part 1, p. 93.)

A brief account of the provisions of the Cotton Standards Act of March 2, 1923, by which all cotton transactions in inter-State or foreign commerce must be conducted in accordance with the official standards of the United States. The Act becomes compulsory twelve months from the date on which the Secretary of Agriculture will announce the standards. The penalties for breach or non-observance of the Act are stated.

108. THE COMMERCIAL CLASSIFICATION OF AMERICAN COTTON. By Arthur W. Palmer. (U.S. Department of Agriculture, *Department Circular*, No. 278, January, 1924.)

In this paper much useful information is given under the following heads: Elements and purpose of cotton classification; classification according to grade,

staple length, and character; relation of classification to value; special conditions affecting value; sampling, and the handling of samples; light and weather conditions, and their influence.

109. COTTON GRADING (U.S.A.). (*Textile World*, 1923, vol. 64, p. 665, etc. Extracted from the *Journal of the Textile Institute*, November, 1923, vol. xiv., No. 11, A. 240.)

The development and periodic revision of cotton standards for comparison is discussed. In order to prevent any change in the official standards, particularly of colour, they are stored in vacuum tubes. The preparation of copies of the standards for general use is described. The principal grading rooms are equipped with specially constructed skylights to provide uniform diffusion of light.

110. THE LABOUR SITUATION IN THE AMERICAN COTTON BELT. By William Whittam. (Abstracted from the *Textile Recorder*, September 15, 1923, vol. xli., p. 49.)

A reply by the American correspondent of the *Textile Recorder* to the *Manufacturers' Record* of Baltimore, which published a contradiction of statements made by him regarding the serious effect of the negro migration on the labour situation in the South Atlantic States.

The writer gives as his warrant for saying that "the negro migration is causing a social revolution in the South" no less an authority than Robert R. Morton, the President of the Tuskegee Institute, Alabama; he also states that legislation is being introduced in some of the Southern States to prevent the recruiting of labour, and quotes from the press and from the correspondence of well-known merchants in the South in support of his contention.

COTTON IN EGYPT.

111. EXPERIMENTAL WORK ON COTTON, 1921. By A. T. McKillop et al. (Egypt Min. Agr. Cotton Research Board Annual Report, No. 2, 1921, pp. 19-56, plates 7. Extracted from the *Experiment Station Record*, August, 1923, vol. xlix., p. 131.)

Abbreviated accounts (*Experiment Station Record*, vol. xlvi., p. 230) describe experimental work conducted under the Cotton Research Board during 1921.

112. (Abstracted from the *International Crop Report and Agricultural Statistics*, November, 1923, p. 502.)

Owing to the unsettled weather in October the picking of the crop was delayed, and part of the picked cotton was spoiled. The second picking has in several districts given better returns than at first expected. Ginning outturns are reported to be poorer than last season.

COTTON IN FOREIGN COUNTRIES.

113. COTTON CULTIVATION. By J. H. Hubback. (*International Cotton Bulletin*, 1923, 2, No. 5, pp. 102-106. Extracted from *Summary of Current Literature*, B.C.I.R.A., January 24, 1924, vol. iv., No. 1, E. 1.)

Brief notes on conditions under which cotton is cultivated in Dutch East Indies, Madagascar, Mozambique, and Angola, the varieties grown and yields obtained.

114. THE COTTON SOILS OF THE MIDDLE NIGER. (*Bul. Mens. Agence Econ. Afrique Occident. Française*, new series 3, 1922, No. 24, pp. 359-372. Extracted from the *Experiment Station Record*, November, 1923, vol. xlix., No. 7, p. 616.)

This is a summary of mechanical and chemical analyses obtained from different sources of samples of the cotton soils from the basin of the middle Niger River in French West Africa.

115. COTTON: FRENCH COLONIES (CULTIVATION). (*L'Avenir Textile*, 1923, 5, pp. 5-6. Extracted from the *Summary of Current Literature*, December 27, 1923, vol. iii., No. 18, E. 34.)

The need for developing the cultivation of cotton in the French Colonies is emphasized, especially the production of cotton of the American type. In this connection specific reference is made to Indo-China and the valley of the Niger.

116. CEARA COTTON. (Abstracted from the *Agricultural Journal of India*, November, 1923, vol. xviii., part 6, p. 657. See also A. S. Pearse in *International Cotton Bulletin*, No. 3, 1923.)

The extensive irrigation works now in course of construction promise to make Ceara State, in the north-east of Brazil, a regular supplier of cotton of 1⅛ to 1⅜ inches staple. On the recommendation of Mr. A. S. Pearse to the Ceara Government and to the Federal Government three large cotton seed farms are being started to grow one variety of seed only, so that a mixture of various strains will finally become next to impossible. The merchants are also organizing themselves to bring about a more up-to-date method of handling cotton.

117. CLASSIFICATION OF BRAZILIAN COTTON. (Extracted from the *Textile Recorder*, November 15, 1923, vol. xli., No. 488, p. 114.)

The Minister of Agriculture is authorized to establish in the principal cities of Brazil the commercial classification of cotton, in order to preclude the possibility of fraud or adulteration in any of the active branches of this industry. The proposed classification of cotton will be based on standard types established by a commission composed of representatives of the cotton industry appointed by the Minister and under the presidency of the superintendent of the cotton service. It will be expressly prohibited, under penalty of a fine, to adulterate the crops in any way by the addition of any extraneous matter likely to destroy the actual quality of the cotton; but in the event of such contravention, the planters involved will be held responsible, as well as the subsequent sellers, merchants, and brokers, and also the cotton exchanges concerned. Trade marks will only be conceded to those possessing effective seed extractors and other machinery requisite for cleaning, ginning, and baling cotton, and for producing the types required; moreover, no cotton will be allowed to be exported in future where the bale does not carry a registered trade mark.

CULTIVATION AND MACHINERY: IRRIGATION, ETC.

118. THE COTTON PLANT IN RELATION TO TEMPERATURE AND RAINFALL. By C. B. Williams, M.A. (Published by the Government Press, Cairo, 1923. Bulletin No. 32.)

A preliminary note containing an instructive comparison of climatic data from some of the cotton-growing areas. Two diagrams are given: the first shows the mean temperature, the average maxima and minima, and the absolute maxima and minima in several countries throughout the year from the planting of the cotton onwards. The second diagram shows similarly the rainfall for the several countries in relation to the cotton seasons.

With regard to temperature, it is shown that there are three important types of relation of the growth of the plant to the prevailing temperature: (i.) The cotton is grown at the warm time of the year between two periods of lower temperature (*e.g.*, Egypt, Texas, Mesopotamia); (ii.) the cotton is grown at the cool time of the year between two periods of higher temperature (*e.g.*, the Sudan and Madras); (iii.) the temperature is more or less constant throughout the year, and is not the factor determining the times of planting and picking (*e.g.*, Nigeria and Brazil).

The rainfall diagram shows that it is rainfall and not temperature that determines the date of the cotton season in Nigeria.

Similar data with regard to other cotton-growing countries are promised.

The world is still working in the dark as to the satisfactory introduction of new varieties, or of old varieties into new cotton-growing areas, and also as to the relationship between quality of staple and the conditions under which it has been grown. The correlation of results, from large numbers of stations, from which reliable data are assured, will help in solving these problems.

119. COTTON CULTIVATION. By W. E. Ayres. (From the *Summary of Current Literature*, B.C.I.R.A., November 29, 1923, vol. iii., No. 16, *Experiment Station Record*, 1923, vol. 49, p. 225; from *Mississippi Station Bulletin*, 1923, No. 215, 14 pp., E. 30.)

120. COTTON CULTIVATION. By W. C. Etheridge and C. A. Helm. (*Experiment Station Record*, 1923, vol. 49, p. 228; from *Missouri Agr. Col. Ext. Circ.*, 1923, No. 122, E. 30.)

Practical suggestions.

121. COTTON CULTIVATION. By W. R. Dunlop. (*Journal Textile Institute*, 1923, vol. 14, pp. 157-161, E. 32.)

122. COTTON CULTIVATION: MALAYA. By J. W. Jack and W. W. Sands. (*Bot. Abstr.*, 1923, No. 12, p. 890; from *Malayan Agricultural Journal*, 1922, No. 10, pp. 248-258, E. 32.)

Among a number of bulletins recently received from the U.S.A. Agricultural Commissioner in London may be mentioned the following:

123. COTTON VARIETIES. By T. S. Buie. (*Georgia Experiment Station*, Experiment, *G. A. Bulletin* No. 136, December, 1920.)

A list of many varieties, with their yields under boll-weevil conditions.

124. COTTON GROWING IN SOUTH MISSISSIPPI. By E. B. Ferris. (*Mississippi Agricultural Experiment Station Bulletin*, No. 196, December, 1920.)

125. REPORT OF COTTON EXPERIMENTS AT THE HOLLY SPRINGS BRANCH EXPERIMENT STATION, SEASONS 1919 AND 1920. By C. T. Ames. (The *Mississippi Agricultural and Mechanical College Bulletin*, No. 192, December, 1920.)

126. COTTON EXPERIMENTS, 1919 AND 1920. By H. B. Brown and C. B. Anders. (*Mississippi Agricultural Experiment Station*, Agricultural College, Mississippi, *Bulletin* No. 187, December, 1920.)

127. SOIL ACIDITY AND LIMING. (Extracted from the *Work and Expenditures of the Agricultural Experiment Stations*, 1921, p. 31. Issued by U.S. Dept. of Agriculture, dated March, 1923.)

In a liming test at the Alabama station corn and cotton were practically ruined, but no other crop was injured.

128. The Pedigreed Seed Company, Hartsville, South Carolina, U.S.A. (Abstracted from the *International Cotton Bulletin*, No. 6, December, 1923, p. 171.)

An account of a visit paid by Mr. Arthur Foster and Mr. Arno S. Pearse to the plantation owned by the above company at Hartsville, South Carolina, during their tour through the Cotton Belt.

The chief varieties of cotton raised by the company, principally for seed purposes, are as follows:

Delta Type (Webber cotton, $1\frac{1}{4}$ to $1\frac{3}{8}$ inches).—Ginning out-turn 31 to 33 per cent. Yield with average farmer, before boll weevil, equals 250 lbs., though on Mr. Coker's own fields the yield is 500 lbs. per acre.

Webber 49 ($1\frac{1}{4}$ to $1\frac{5}{16}$ inches).—As above.

Lightning Express ($1\frac{3}{16}$ to $1\frac{1}{4}$ inches).—As above.

Cleveland Big Boll ($\frac{7}{8}$ to $1\frac{1}{16}$ inches).—Ginning out-turn as much as 38 to 40 per cent.

Mr. David C. Coker, the President of the organization, has for years concentrated on the cultivation of Cleveland Big Boll, and now has numerous strains of excellent character and high yields which will run from 36 to 38 per cent. lint, and which will staple commercial $1\frac{1}{8}$ to full $1\frac{1}{8}$ inches. He also states that he has one strain of this cotton that is yielding considerably more than a bale an acre, and the seed will be available for distribution a year hence.

129. Cultivation, etc. The *Report on the Agricultural Stations of the Western Circle, United Provinces, India*, for the year ending May 31, 1923, contains results of experiments upon cottons of various types, but to quote the results for a single year would be very misleading. They do not, in general, show very good returns.

130. Summer Irrigation of Pima Cotton. By R. D. Martin and H. F. Loomis. (*Journal Agricultural Research*, U.S., 23, 1923, No. 12, pp. 927, 946, figs. 4. Extracted from the *Experiment Station Record*, September, 1923, vol. xlix., No. 4, pp. 330-331.)

Experiments were conducted at Sacaton, Arizona, by the Bureau of Plant Industry, U.S. Dpt. Agr., to determine the effects of different frequencies of irrigation during July and August on Pima Egyptian cotton that had reached a normal early fruiting stage. The treatment included normal irrigation or the application of water, so as to keep the plants flowering heavily and with little or no wilting in the middle of the day; a " heavy " border receiving irrigations at frequent intervals regardless of the condition of the plants or soil; and an intermediate irrigation treatment.

The different frequencies of irrigation after the plants had reached a normal fruiting stage did not cause any consistent significant difference in growth or yields, nor did the rates of flowering or of shedding of young bolls vary consistently under any of the treatments. A wide range in the daily flowering production occurred, and the rate of shedding of young bolls also varied from day to day. Correlation between these fluctuations and factors which might be supposed to influence this phenomenon could not be definitely established. No consistent increase or decrease at a regular interval after an irrigation was found either in the flowering or in the shedding of young bolls. Shedding of young bolls was greatest from four to fourteen days after flowering. The shedding of flower buds, or "squares," was almost negligible throughout the experiment. The yield differences found are ascribed to soil heterogeneity rather than to the different frequencies of irrigation or to the loss of bolls by shedding.

The importance of controlling the early development of cotton in order to bring the plants to a normal early fruiting stage is emphasized. When this condition is attained, the summer irrigation problems are simplified, since the plants are not so easily forced into rank growth by the application of water in excess of the actual requirements (*cf.* abstract 73).

131. COTTON STAPLE TEST. By H. Fluhr. (*L'Ind. Text.*, 1923, vol. 39, pp. 156-162. Abstracted from the *Agricultural Journal of India*, November, 1923, vol. xviii., part 6, p. 659.)

In this paper several new methods of obtaining mean staple lengths and staple diagrams are described.

132. COTTON MARKETING. By B. H. Hird. (*Proc. Text. Inst.*, No. 14, 1913, pp. 269-272. Extracted from the *Summary of Current Literature*, B.C.I.R.A., vol. iii., No. 17. Issued December 20, 1923. E. 33.)

"A report of a lecture on the grading and marketing of cotton in which a short survey of the growth and preparation of American cotton in relation to the main causes of the differences in grade and quality is given."

133. GROUNDING COTTON GINS TO PREVENT FIRES. By H. E. Roethe. (*U.S. Dept. Agric. Dept. Circ.*, 271, 1923, pp. 4, fig. 1. Abstracted from the *Experiment Station Record*, December 15, 1923, Abstract No., vol. xlix. No. 6, pp. 590-591.)

Practical information on the grounding of cotton gins to prevent fires resulting from the generation of static electricity in moving parts is briefly presented.

134. CLEANING COTTON. By R. B. Smith. (*Cotton*, 1923, vol. 87, pp. 659-660. Abstracted in *Agricultural Journal of India*, January, 1924, vol. xix., part 1, p. 97.)

135. COTTON HARVESTER: DESCRIPTION. (*Journal Textile Institute*, 1923, No. 14, A. 216; from *Cataluna Textile*, 1923, No. 17, p. 111. Extracted from the *Summary of Current Literature*, December 27, 1923, vol. iii., No. 18, E. 34.)

A machine patented by the General Electric Company works by the play of two cylindrical rotating brushes actuated by a flexible shaft about a yard long, and set in a metal frame presenting an aperture large enough for the passage of a cotton boll. The frame is fixed to a tube, at the end of which is a sack for collecting the cotton. Half-way down the tube is an electric motor for working the flexible shaft, and just inside the tube, below the brushes, is a suction device and centrifugal separator worked by a second motor. The machine covers eight rows of cotton plants at a time, and the workmen direct the four suction tubes of the machine under each plant. The brushes exert a sort of combing action as they pick the cotton. The machine can gather 500 to 660 lbs. of cotton per day.

DISEASES, PESTS AND INJURIES, AND THEIR TREATMENT.

136. THE PINK BOLL WORM IN THE UNITED STATES. (Extracted from the *Journal of the Textile Institute*, November, 1923, vol. xiv., No. 2.)

A Quarantine Notice (No. 8) issued by the Tennessee State Board of Entomology, March 17, 1922, illustrates the methods being adopted to combat the ravages of this pest, *Pectinophora gossypiella*, Saunders. The notice states

that the pest is known to exist in Texas, Louisiana, and New Mexico, and that the cotton interests of Tennessee should be protected against its introduction. Under the requisite authority notice is given that cotton, cotton seed, seed cotton, cotton seed hulls, cotton lint, cotton mill waste, cotton linters, cotton waste, cotton sweepings, cotton samples, and damaged and redried cotton are plants and plant products which are likely to be infected with said insect pests and that the importation of the plants and plant products herein listed from areas where the pink boll worm is known to exist is hereby prohibited, except under such rules and regulations as may hereafter be promulgated by the Board.

"We recommend cotton seed sterilization by heating machinery and by methods as approved by, and certified to, in accordance with rules and regulations established by the Federal Horticultural Board, as an additional safeguard which should be applied immediately, particularly to all planting seed in all States where infestation is known, whether such seed is destined for intra-State or inter-State movement, and such sterilization should be extended as rapidly as may be possible to include all cotton seed at the time of ginning.

"We believe that cotton lint grown outside of regulated zones in any infested State may, when properly baled, be allowed unrestricted inter-State movement with safety."

To this may be appended the following extracts relating to the treatment of cotton seed against pink boll worm:

137. COPY OF RESOLUTION OF THE INTERNATIONAL COTTON CONFERENCE HELD IN RIO DE JANEIRO, OCTOBER, 1922: MEANS TO BE TAKEN FOR COMBATING THE PINK BOLL WORM.

14 (*d*). The farmer should immerse the seed for two minutes in hot water; the temperature to be not less than 55° and not more than 60° C. This is recommended as a sure remedy for the destruction of the insects.

138. MACHINES FOR THE TREATMENT OF COTTON SEED AGAINST PINK BOLL WORM. By G. Storey. (Published by the Ministry of Agriculture, Egypt.) P. 14.

"Hot-water treatment for five minutes shows a distinct loss in germination at 65° C., which is increased at 70° C. At 60° C., however, the damage is at most slight, and in all probability non-existent."

See also THE PRESENT SITUATION WITH REGARD TO THE CONTROL OF THE PINK BOLL WORM IN EGYPT. By G. Storey. (Published by the Ministry of Agriculture, Egypt.) P. 13.

". . . One can say absolutely definitely that if excessive temperatures—*i.e.*, over 70° C.—are avoided, no harm whatever is done to the germination of the seed."

139. U.S. DEPT. OF AGRICULTURE REPORT ENTITLED "WORK AND EXPENDITURES OF THE AGRICULTURAL EXPERIMENT STATIONS, 1921" (dated March, 1923, p. 373).

"It was found that the pink boll worm is readily killed at a temperature of 125° to 130° F., and cotton seed will stand temperatures of 175° to 180° F. for several hours."

These apparently conflicting recommendations were referred to Mr. E. E. Green, President of the Entomological Society, and formerly Government Entomologist in Ceylon, who replied:

"Here is what your extracts convey to my mind. I believe that the temperatures in all three statements refer to hot water, and that the disagreements are due to differences of experience and opinion of the three observers.

"No. 1 gives the range of safety as lying between 50° and 65° C.

"No. 2 (*a*) gives the range of safety as lying below 60° C.

"No. 2 (*b*) gives the range of safety as lying below 70° C.

"No. 3 gives the range of safety as lying between 51° and 74° C.

"They all agree in implying that temperatures of between 55° and 60° C. are effective. Ergo, as this range appears to be both safe and effective, it would be advisable to keep within it.

"The differences of time are certainly very wide, varying as they do from 'two minutes' to 'several hours.' I should regard the lower figure as inadequate to ensure complete disinfection, and the higher figure as unnecessary and inconvenient in practice. A period of from ten to fifteen minutes would be more reasonable."

140. The Pink Boll Worm (*Pectinophora gossypiella*). (Abstracted from the *Report on the Agricultural Department*, Montserrat, 1921-22, p. 7.)

Gives an account of the ravages effected by this insect since its introduction into Montserrat, and the measures taken against it, with their results.

141. Recent Work on the Pink Boll Worm. By the late G. Storey. (*Cairo Scientific Journal*, 1923, vol. xi., p. 15.)

A review of the history of the spread of this pest, the quarantine regulations against it, the control measures, and the field campaign.

142. The Fumigation of Cotton Seed with Chloropicrin. By P. Vayssière. (*Agron. Colon.* 7, 1922, No. 56, pp. 249 253. Extracted from *Experiment Station Record*, August, 1923, vol. xlix., No. 2, p. 154.)

In three experiments here reported, made in 1921 and 1922 with cotton badly infested with the pink boll worm and with perfectly sound seed, it was found that chloropicrin at the rate of 30 c.c. per cubic metre with an exposure of twenty-four hours gives complete disinfection to seeds without affecting their germination.

143. Experiments on Cotton Seed in Australia. (Abstracted from the *Textile Recorder*, September 15, 1923, vol. xli., p. 50.)

An interesting description of the methods adopted for disinfecting cotton seed, and the effect of treatment on the seed.

The spores of many serious diseases are borne in the lint attached to the cotton seed. To effect their destruction it is necessary to remove the lint, and concentrated sulphuric acid is stated by the authors to be an efficient and cheap way of delinting the seed. After immersion in the acid the seed is drained, and then washed in a large volume of running water.

Experiments proved that immersion in sulphuric acid up to four hours had no effect on the capability of the seed to germinate.

Treated seed germinated more quickly, and the plants were far more healthy and vigorous than those from non-treated seed.

The necessity for the treatment of all imported samples is shown by the isolation of a pathogenic fusarium from an imported cotton seed sample. Its pathogenicity has been demonstrated.

One of the most striking exhibitions seen during the course of the experiments was the strong vitality of cotton seed under circumstances that might have been presumed to be completely destructive. On the other hand, it was proved that the seed is very sensitive to a comparatively small increase of temperature, and is injured by it.

144. MILL USE OF FUMIGATED COTTON SUBSTANTIALLY WITHOUT RISK. (Extracted from the *Textile Recorder*, December 15, 1923, vol. xli., No. 489, p. 71.)

The fumigation with hydrocyanic gas of all cotton entering the United States has been required now for the past six years, and the Board believes that in the ordinary mill use of such cotton there is no risk whatever of injury to employees, and no complaints have been received from any mills of any ill effects from such cotton.

The only possible risk from the utilization of fumigated cotton would be in the rooms for initial opening, or perhaps also in tightly-constructed storage rooms where a considerable number of bales are stored. As already indicated, the risk in connection with mills and storage companies handling such cotton is apparently negligible, but to eliminate all possibility of risk adequate ventilation in storage and opening rooms should be provided. The fact that the disinfecting gas is lighter than air will cause any of it which may escape from the cotton to accumulate at the top of the room or storage place, and ventilation provided for should take this into account. Such ventilation can be effected by means of windows or by exhaust fans.

145. INSECT PESTS OF COTTON IN ST. CROIX AND MEANS OF COMBATING THEM. By C. E. Wilson. (*Virgin Islands Stat. Bull.*, 3, 1923, ii+20 pp., figs. 21. Extracted from the *Experiment Station Record*, September, 1923, vol. xlix., No. 4, p. 352.)

In this bulletin the author describes the life-history of some of the insects thus far known to attack cotton in St. Croix, and means for combating the more destructive species. The pests considered include the cotton worm (*Alabama argillacea*), blister mite (*Eriophyes gossypii*), fall army worm, cotton boll cut worms (*Prodenia ornithogalli* and *P. latifascia*), West Indian sugar-cane root borer (*Diaprepes abbreviatus*), tropical cut worm (*Xylomiges sunia*), cotton aphid, cotton lace bug (*Corythucha gossypii*), red spider (*Tetranychus telarius*), and a number of other pests which attack the leaf and stem, and the pink boll worm, southern green stink bug (*Nezara viridula*), cotton stainer, boll worm, flower-bud maggot (*Contarinia gossypii*), St. Croix boll worm (*Heliothis virescens*), pink scavenger worm (*Pyroderces rileyi*), plant bug (*Phthia picta*), spined stink bug (*Arvelius albopunctatus*), and the large squash bug (*Leptoglossus gonogara*), which attack the boll and flower.

146. COTTON DISEASES. (From the *Work and Expenditures of the Agr. Exp. Stations*, 1921, p. 59. Issued by the U.S. Dept. of Agr., dated March, 1923.)

Cotton anthracnose, which formerly caused a loss of from 2 to 5 million dollars annually in South Carolina, is now practically under control, with negligible losses, largely as a result of investigations at the South Carolina station. Preliminary drying and one-year storage of the seed apparently will control this trouble. The angular leaf spot of cotton was also studied by this station, which finds it to be seed-borne, and not carried in the soil. Absolute control is secured by delinting the seed with sulphuric acid and treating with mercuric chloride, which also reduces the infection from anthracnose and ensures quicker germination. The disease is spread by rain, but if fields are separated by corn it will not spread in this way.

A new disease of cotton, noted by the Arkansas station, is found to be due to a *Phoma* sp. The organism has been isolated, its life-history worked out, and its pathogenicity established by inoculation experiments.

The Texas station finds that the organism causing Texas root rot, *Ozonium omnivorum*, carries over winter not only on fleshy roots, such as sweet potatoes, carrots, or beets, but also may live over on cotton plants, the roots of which remain alive during the winter. Indications are that it is not carried over in the soil. These facts suggest effective means for its eradication.

147. COTTON ANTHRACNOSE: CONTROL. G. F. Lipscomb and G. L. Corley. (*Rev. Appl. Mycology*, 1923, **2**, p. 500; from *American Fertilizer*, 1923, 58, pp. 32-34. Extracted from the *Summary of Current Literature*, B.C.I.R.A., vol. iii., No. 17. Issued December 20, 1923. E. 33.)

"It is shown that by thoroughly heating and drying cotton seed in a vacuum or any inert atmosphere, such as nitrogen, to prevent oxidation of the fats and proteins in the seed, they can endure temperatures of 100° C. for hours without any diminution of vitality, and even 110° to 120° C. for several hours without destroying life. Anthracnose is destroyed by this treatment, and simultaneously germination is stimulated to a remarkable extent. In all experiments highly infected Weber 49 seed was used. The apparatus used in the laboratory for treating the seed is described."

148. COTTON SEED: VIABILITY. By G. F. Lipscomb and G. L. Corley. (*Science*, 1923, 57, pp. 741-742. Extracted from the *Journal of the Textile Institute*, November, 1923. vol. xiv., No. 11, A. 240.)

Much the same as **147.**

BREEDING.

149. STUDIES IN INHERITANCE IN COTTON. I.—HISTORY OF A CROSS BETWEEN GOSSYPIUM HERBACEUM AND G. NEGLECTUM. By G. L. Kottur, M.Ag., Cotton Breeder, S. Mahratta country. (*Mems. Dept. Agr. India*, Botanical Series, August, 1923, vol. xii. Price Re 1.)

A short account is given of previous crosses made in the Bombay presidency. The object of the present cross was to obtain a cotton for the Kumpta cotton area combining the high ginning character of the *neglectum* (var. *rosea*) with the good staple of the Kumpta type of *herbaceum*. While the ginning percentage of the latter was 28 per cent. (mean), and that of *rosea* 35·1 per cent., that of the F_1 cross was 34·2, showing that the high ginning percentage was largely prepotent, if not completely dominant. In the F_2 generation, 74·8 per cent. of the offspring were of high ginning percentage, against 1 per cent. in the Dharwar No. 1 *herbaceum*, and this superiority continued in F_3. Further details of the two types that showed in the latter generations are given, but are too long for abstract. In length of staple the cotton was almost, but not quite, as good as the Dharwar No. 1.

The relation between ginning percentage and staple length is then considered. The figures rather go to show that these characters vary independently, and are not, as usually supposed, correlated. This conclusion, if confirmed, is of importance, as it might make possible the production of high ginning percentage with long staple, a thing which would tend to alter the place now occupied upon the markets by Indian cottons.

150. GOSSYPIUM HERBACEUM × NEGLECTUM: CHARACTERISTICS. By G. L. Kottur. (*Mem. Dept. Agric. India* [*Pusa*], Botanical Series, 1923, **12**, pp. 71-133.)

We may also note the following, recently received from the United States Department of Agriculture:

151. Results of Seven Years' Pedigree Selection in Trice Cotton. By Edgar A. Hodson. (*Univ. of Arkansas, Coll. of Agr., Agr. Exp. Sta. Bull.*, No. 171, June, 1920.)

152. Cotton Fertilization Experiments, 1920. By F. H. Smith and T. S. Buie. (*Georgia Exp. Sta. Bull.*, No. 137, Dec., 1920.)

153. Varieties of Cotton, 1919 and 1920, and Summary of Ten Years' Results, 1911-1920, Delta Branch Station. By W. E. Ayres. (*Miss. Agr. Epx. Sta. Circular*, No. 36, Jan., 1921.)

154. Cultural Experiments with Cotton, Delta Branch Station. By G. B. Walker and W. E. Ayres. (*Do., Circular*, No. 35, Jan., 1921.)

155. Cotton Variety Experiments, Substation No. 3, Angleton, Texas. By E. B. Reynolds. (*Texas Agr. Exp. Sta. Bull.*, No. 274, Feb., 1921.)

156. The Staple of Texas Cotton. By E. P. Humbert. (*Do., Bull.*, No. 266, Ag., 1920.)

157. Upland Long Staple Cotton in Arkansas. By Edgar A. Hodson. (*Univ. of Arkansas, Coll. of Agr., Agr. Exp. Sta. Circular*, No. 49, March, 1920.)

158. Correlations of Certain Characters in Cotton. By Edgar A. Hodson. (*Do., Bull.*, No. 169, June, 1920.)

LEGISLATION.

A further mass of Ordinances, etc., has been received, from which we extract the following:

159. Antigua (West Indies).—The Export Duty Ordinance, 1923, fixes an export duty upon cotton, where the price per pound of clean lint is:

Under 2s. 6d. a pound	One halfpenny.
2s. 6d. a pound and over	One penny.

An Order in Council of December 9, 1920, prohibits the importation of cotton seed and seed cotton, etc., into the Presidency of Antigua.

The Plant Protection Ordinance, No. 16 of 1923, gives the Governor the usual powers of registration, inspection, quarantine, destruction of infected plants, etc.

160. Australia.—A Proclamation from the *Commonwealth of Australia Gazette*, No. 75, dated October 25, 1923, states that the pink boll worm pest exists in the north-western portion of Western Australia, and prohibits the removal of cotton seed or lint into other parts of Australia, except the Northern Territory, which is already subject to the pest.

161. Ceylon.—A consolidating Ordinance to make provision for preventing the introduction and spreading of weeds and of pests and diseases injurious to or destructive of plants is published in the *Gazette* of November 25, 1923, adding to and uniting previous Ordinances on the subject.

162. Gold Coast.—The Director of Agriculture reports: "We have had a 'Destructive Pests Ordinance' since 1912 (No. 2 of 1912), and rules were adopted under it prohibiting the importation of cotton seed except under a licence issued by the Director of Agriculture; but cotton being a very minor industry here, no other internal legislation or Orders have been considered necessary hitherto.

"This Ordinance has now been superseded by the Plants (Injurious Pests) Ordinance (No. 37 of 1923), which has just become law, and embodies the same provisions with regard to cotton."

163. KENYA COLONY.—*The Kenya Cotton Rules*, 1923, give power to the Director of Agriculture to supply or requisition seed for sowing; destroy seed from hand gins; prohibit removal or sowing of seed; destroy infected seed; order all cotton plants, etc., to be destroyed at the end of the season.

Licences are issued to people enabling them to buy or sell unginned cotton at specified places. Licensees must keep books of account, details of purchases, etc.

Licences are also issued by the Director of Agriculture for ginneries, and returns must be made monthly of quantities ginned and baled, etc.

The Kenya Cotton Ordinance of 1923 empowers the Government to deal with all matters relating to importation and exportation of cotton seed, inspection, quarantine, destruction of infected plants, issue of licences, etc.

164. NIGERIA.—Regulations have lately been made under the Agricultural Ordinance (chap. 96) to come into force on January 1, 1924.

They are chiefly devoted to the grading and marketing of cotton. No seed may go into a cotton market until graded, nor may any be removed after purchase unless graded after such purchase. The grades fixed are N.A. 1, N.A. 2, N.N. 1, N.N. 2, N. 3, in descending order of merit, and a ticket must be given by the grader, to be delivered to the purchaser.

In some provinces grading is made compulsory. Ginning licences are required, and mixing of grades is prohibited. Bales for export must be marked with the name of owner and ginnery.

165. QUEENSLAND.—The *Cotton Industry Act of* 1923 contains a number of provisions, among which may be quoted:

(6) (i.) During the period proclaimed by the Governor in Council as the period for or during which the Crown guarantees a price for seed cotton, the Governor in Council may, by Order in Council, from time to time acquire for the Crown the whole or, in his discretion, any part of any cotton grown within the State.

(Under these circumstances other ownership is void.)

(7) (i.) The prices of cotton acquired by the Crown under this Act shall be fixed by the Governor in Council, and may be different, having regard to different qualities or to market conditions, or to localities of delivery, or to circumstances or conditions of production, or to any other fact or circumstance which the Governor in Council thinks it proper to take into consideration; and the prices so fixed and no other prices shall be payable to the late owners respectively concerned, but shall not be less than the price guaranteed by the Government during the period aforesaid as may be prescribed by the Regulations.

(9) (i.) The Minister may make advances to growers on account of the purchase price of cotton acquired by His Majesty under this Act:

> Not exceeding an amount equal to fivepence and one halfpenny a pound for cotton of good quality and length of staple as prescribed by the Regulations, and a less amount for cotton of good quality of a less length of staple as prescribed by the Regulations, delivered as prescribed by the Minister during the year ending the thirty-first day of July one thousand nine hundred and twenty-four; and
>
> Such sum per pound as he may think fit, but not exceeding fivepence and one halfpenny a pound for cotton delivered at an authorized factory during the years ending respectively the thirty-first day of July one thousand nine hundred and twenty-five and the thirty-first day of July one thousand nine hundred and twenty-six:

Provided that no such advance shall be made to any grower for cotton grown by such grower in respect of any area or areas exceeding fifty acres in all.

(10) (i.) No cotton acquired by His Majesty under this Act shall be ginned at any place other than an authorized factory.

(12) The Minister shall sell to the best advantage at a price to be determined by public tender or by auction all cotton acquired by His Majesty under this Act, and with respect to all such cotton on which an advance under this Act has been made to the grower, if the proceeds of such sale exceed (after deducting the cost of ginning and marketing and other incidental expenses) the amount of such advance, shall pay the amount of such excess to the grower.

(13) After the date of the passing of this Act—

(*a*) No ratoon cotton plants shall be grown;
(*b*) No person shall send ratoon cotton to an authorized factory;
(*c*) No person shall grow any cotton plants within the State except for commercial purposes.

Part III. (paragraphs 14 to 28) deals with the prevention of disease, and among other provisos calls upon the grower to notify within a week any disease he may notice. Power is given to establish quarantine in any way required, whether against introduction of disease from abroad or against spread of local diseases; also to compel destruction of infected plants, etc.

In Part IV. (Miscellaneous), among other things, the cultivator is required to notify the date of planting, as well as area and variety of cotton employed.

166. Rhodesia (Northern).—Government Notice No. 133 of 1923 prohibits importation of seed cotton or cotton seed from North-Eastern Rhodesia into North-Western Rhodesia, or *vice versa*, without a permit from the Administrator.

167. Rhodesia (Southern).—A Government Notice dated November 30, 1923, prohibits the importation of cotton seed and seed cotton into Southern Rhodesia from places outside British South Africa except under the direct supervision of the Director of Agriculture, and from places within British South Africa except by permit from the Director of Agriculture.

168. Rhodesia (Southern).—A proclamation by the Department of Agriculture states that "no cotton the produce of Southern Rhodesia may be imported into the Union of South Africa unless accompanied by a permit, which may be obtained from the Director of Agriculture, Salisbury, and issued by him on behalf of the Government of the Union of South Africa.

"Cotton seed intended for sowing will only be admitted into the Union on special permission, application for which should in the first instance be addressed to the Director of Agriculture, Salisbury."

169. Sierra Leone.—The Director of Agriculture reports in a letter dated January 11, 1924, that there is no legislation relating to cotton.

170. South Africa.—In response to an enquiry about legislation affecting cotton, an official letter has been received from the Chief of the Tobacco and Cotton Division of the Department of Agriculture, which says that "at present there is no Regulation in force governing the actual growing of the cotton crop in South Africa, although this division has a staff of itinerant experts who visit growers throughout the Union, giving them advice as to the best methods of culture and general handling of the crop from the time of planting to picking. It is due in a large measure to the useful and timely advice given to farmers by the officers of this division that the cotton industry has increased to such a great extent. The marketing, ginning, and export of cotton is directly under the control of this division, each bale of cotton is graded by an official grader, and before exported has to be clearly stencilled showing (*a*) the registered mark of ginner; (*b*) typemark assigned thereto by the grader; (*c*) the number of the bale. A charge of 1s. per bale is made for the grading of each bale."

The Regulations governing the export of cotton are given as *No.* 642 *of April* 16, 1923.

A special levy fee of one shilling for each 100 lbs. or portion thereof of lint has to be paid on any cotton exported, and for each 300 lbs. or portion thereof of seed cotton exported the sum of one shilling. Moneys collected by this special levy of one shilling per 100 lbs. lint or portion thereof are to be used for the fostering of our new and promising cotton industry, and are not placed in the general revenue account of the Government. The Regulations prescribing the fees payable in respect of the export of cotton lint and seed cotton are given as *No.* 643 *of April* 16, 1923.

The Government also has the control of the importation of cotton seed into the Union of South Africa, and provision is made in the Agricultural Pests Act, No. 11 of 1911, requiring that a permit must be obtained to import any cotton seed into the Union. The Regulations governing the importation of cotton seed and raw cotton into the Union of South Africa are given as *Notice No.* 10 *of* 1919.

There is no Act at present in force dealing with the control and maintenance of supplies of pure seed, although every effort is being made by this division to supply pure strains of cotton seed for planting purposes. The cotton industry has advanced so rapidly the last few years that it is difficult to cope with the increasing demand for better seed, as growers have realized the importance and value of good seed.

171. SUDAN.—From the *Agricultural Handbook*, 1920, of the Sudan Government, which contains the Ordinances, Regulations, etc., relating to agriculture published in the *Sudan Government Gazettes*, we quote the following relating specifically to cotton:

The Plants Diseases Ordinance, 1911. *Order : Cotton Seed.* (Published in *Sudan Government Gazette*, No. 315, dated March 16, 1917.)

Prohibits the bringing of seed cotton, cotton lint, cotton seed, cotton plants, and any parts thereof, from the Red Sea Province into any other part of the Sudan except by, or under the authority of, the Director of Agriculture.

The Plants Diseases Ordinance, 1911. *Notice : Pink Boll Worm.* (Published in *Sudan Government Gazette*, No. 315, dated March 16, 1917.)

Decrees that the pink boll worm (*Gelechia gossypiella*) be a proclaimed disease.

The Cotton Ordinance, 1912. *No.* 4 *of* 1912. (Published in *Sudan Government Gazette*, No. 225, dated November 23, 1912.)

An Ordinance for improving and maintaining the quality of cotton in the Sudan and other purposes.

The Cotton Regulations, 1913. (Issued under the Cotton Ordinance, 1912. Published in *Sudan Government Gazette*, No. 230, dated February 20, 1913.)

Cotton Regulations, 1913. *Notice : Cotton Seed.* (Published in *Sudan Government Gazette*, No. 232, dated March 20, 1913.)

Decrees that "Mit-Affifi" be the only cotton seed sown by cultivators in the Tokar District, the seed to be supplied by, or under the authority of, the Agricultural and Forests Department.

The Cotton Regulation, 1914. (Published in *Sudan Government Gazette*, No. 251, dated April 15, 1914.)

This Regulation is incorporated in Section 4 of the Cotton Regulations, 1913.

The Cotton Regulations, 1917. Regulations amending the Cotton Regulations, 1913. (Published in *Sudan Government Gazette*, No. 315, dated March 16, 1917.)

The Kassala Cotton Regulations, 1917. (Published in *Sudan Government Gazette*, No. 325, dated November 8, 1917.)

172. SWAZILAND.—Proclamation No. 63 of 1921 states that it is lawful for the High Commissioner to make, alter, and repeal regulations for—

(*a*) Regulating the importation of cotton plants or seeds.
(*b*) The requisitioning or compulsory purchase by the Swaziland Administration of cotton seed in Swaziland suitable for sowing purposes.
(*c*) The destruction of all cotton plants or portions thereof after the season's crop has been picked.
(*d*) Dealing with diseases affecting cotton.
(*e*) The regulation of the planting, cultivation, and harvesting of cotton.

And the High Commissioner's Notice of September 12 says that cotton seed may only be imported into Swaziland under permit; that the plants after cropping must be destroyed by fire and the roots lifted; also that no cotton shall be grown from seed not up to a certain standard.

173. TANGANYIKA TERRITORY.—Regulations of 1923 have been received fixing dates for uprooting and burning cotton plants, and reducing fees for licences to purchase and gin cotton.

174. TANGANYIKA TERRITORY. — Government Notice No. 227, under the Cotton Rules, 1922, prohibits the purchase of native-grown cotton in Lindi, Morogoro, and Tabora Districts.

175. AN ABSTRACT OF THE LEGISLATION IN FORCE IN THE BRITISH EMPIRE DEALING WITH PLANT PESTS AND DISEASES UP TO THE YEAR 1920. Compiled by E. M. Ralfs. (Lond. Imp. Bur. Ent., 1921, pp. 65. Extracted from *Experiment Station Record*, Abstract No., December 15, 1923, vol. xlix., No. 6, p. 540.)

A condensed account, with index, is given in systematic form of plant pest and disease laws in force to 1920 in continental and island areas (separately treated) under British control.

CO-OPERATION.

176. CO-OPERATION. (Extracted from *Queensland Agr. Journ.*, October, 1923, vol. xx., part 4.)

Co-operation, like Mesopotamia to the Imperial statesman of the last general tion, has become a blessed word in the farmer's vocabulary; and while the attention of agriculturists is being focused more strongly than ever on the need for business combination, it may be well to give some time to a short review of its guiding principles. Co-operation is not a panacea for all the ills of the farming industry; there is no particular form of magic in the word; it is not a sort of cult covering all the farmer's corporal and spiritual necessities; its adoption does not involve an abandonment of common-sense business principles; it is no remedy for incompetent or out-of-date farming. All it means, briefly, is just a group of individuals with mutual interests combining to secure by prudence, efficiency, and mutual aid more equitable business conditions. The success of the co-operative movement in other countries, particularly among small holders in Denmark, has generated an enthusiasm for a general application of its principles—principles often misunderstood by some of its most clamant advocates. It must, however, be remembered that success in co-operative endeavour, like success in other business ventures, can only be attained by carefully-planned growth and well-directed effort, in which every member of the combination has been educated to a proper appreciation of the merits and difficulties of this kind of commercial or industrial activity. To be faced at times with almost insuperable obstacles and to meet with discouraging setbacks is a common experience of any co-operative organization.

In order to prepare co-operators for these common experiences of co-operative ventures, to strengthen them in their loyalty and good-will towards their own enterprises at inevitable crises in group action, education is indispensable. In prosperous co-operative organizations there is a bond of interest created and maintained only by a constant feeling on the part of members that their venture is well worth while. Such a feeling is engendered and intensified by the sort of education that cultivates a sound knowledge of, and a firm faith in, the underlying principles of the co-operative movement.

Production and marketing must necessarily be on a large scale plan if they are to fit in with the demands of modern conditions, and to the farmer the easiest way to engage in big business is through co-operation. A co-operative enterprise is primarily one of business. Its object is to reduce costs on the come and go of the farmer's needs and products, to cheapen supplies, to lower production costs, to improve marketing facilities, and to provide adequate credit. The materialistic aspect of co-operation is the side that makes the first and strongest appeal to the farmer, but in his absorption in the prospects of immediate material gain he often loses the true spirit of co-operation, the spirit that is of real social significance. "Once a society becomes a soulless corporation its days are numbered." We quote Plunkett, the great Irish authority: "How many co-operative societies, starting with high hopes, and apparently inspired vision, have failed because the spirit of mutual aid has become atrophied and died ?" "Co-operation," says Smith Gordon, "is the concrete expression of the associative spirit which is ever present in humanity. It represents the reaction in ordinary men of humble position against the tyranny of a social order which has thrown all the advantages of combination into the hands of the rich and powerful."

The life-infusing force of the co-operative movement is the spirit of mutual aid. Agricultural co-operation the world over is rooted in economic necessity; it develops from a real need for mutual aid, and though a product of hard, cold realism it is not without a palpitating idealism—the true co-operative spirit without which the movement would be as a husk without corn. Queenslanders have no need to look beyond the borders of their own State for outstanding examples of co-operative success. In the dairying industry alone co-operative progress has been phenomenal. Co-operative principles are being extended to other branches of the farming industry, and further extensions are planned. The need for united effort, the primary factor, is already sharply felt in every section of the industry, but there are other essentials which the co-operating farmer must also take into account. Sound business must be the basis of any new organization. It must be competently directed by men who mean business and who understand business; its members must be taken into the confidence of its directorate; they must fully realize the aims, possibilities, obstacles, and responsibilities, individually and collectively, that pertain to the undertaking. Experience teaches that each and every co-operator should have a clear and complete knowledge of the principles of co-operation. Co-operative success is otherwise bound up in sufficient business; faith in the co-operative idea; existence of the real spirit of mutual help; adequate capital; sound accountancy; loyalty; leadership—and managerial brains at least equal in quality to the brains of the entrenched interests that co-operators will have to fight.

MISCELLANEOUS.

177. COTTON IN THE CURRENT LITERATURE OF (EGYPT AND) THE WORLD. (Egypt. Min. Agr., Cotton Research Bd. Ann. Rept., 2, 1921, pp. 83-176. Extracted from the *Exp. Sta. Rec.*, Aug., 1923, vol. xlix., p. 131.)

Summaries are given of current official and other publications relating to cotton in Egypt and throughout the world.

178. SUMMARY OF BOTANICAL WORK ON COTTON CARRIED OUT IN EGYPT UP TO 1918. By A. T. McKillop et al. (Egypt. Min. Agr., Cotton Research Bd. Ann. Rept., 2, 1921, pp. 177-183. Extracted from the *Exp. Sta. Rec.*, Aug., 1923, vol. xlix., p. 131.)

Papers omitted from the list noted earlier (*E.S.R.* 46, p. 230) are summarized.

179. RAW COTTONS: IDENTIFICATION. By R. Haller. (*Textilberichte*, 1923, **4**, pp. 325-326. Extracted from the *Journ. of the Text. Inst.*, December, 1923, vol. xiv., No. 12, A. 268.)

A method for identifying different cottons in the raw state or in unbleached yarn or cloth is outlined. The method is based on the characteristic appearance under the microscope of the broken leaf and husk separated from the material of unknown origin. The "hairiness" of the leaf is particularly characteristic, and for many varieties the length ratio of the lumen to the woody part of the seed coat and the presence or absence of linters and the colour of the linter are also characteristic. Full details are promised in a booklet which is in the press.

180. WEST INDIES: IMPERIAL AGRICULTURAL COLLEGE. (Extracted from the *West Indian Committee Circular*, Jan. 17, 1924, vol. xxxix., No. 660, p. 24.)

The foundation-stone of the permanent buildings and laboratories of the Imperial College of Tropical Agriculture at St. Augustine, Trinidad, was laid by His Excellency Brigadier-General Sir Samuel Wilson, K.C.M.G., K.B.E., C.B., Governor of Trinidad and Tobago, on Monday, January 14, in the presence of a distinguished gathering, including Sir Francis Watts, the Principal; Sir Arthur Shipley, Chairman of the Governing Body; Captain Arthur Hill, Director of Kew; Dr. S. A. Neave, representing the Bureau of Entomology; Mr. S. P. Wiltshire, representing the Bureau of Mycology; and Mr. Algernon Aspinall, Secretary.

His Excellency read a message from the Prince of Wales expressing his satisfaction that the great plan of scientific research and agricultural development for the tropics was now an accomplished fact. Messages were also read from the Earl of Harewood (President of the West India Committee), Lord Milner, Lord Burnham, the British Cotton Growing Association, and the Empire Cotton Growing Corporation.

181. WEST INDIES. (*Tropical Agriculture*, the journal of the Imperial College of Tropical Agriculture, Trinidad, January, 1924, vol. i., No. 1. (Monthly, 6d.)

A journal dealing with tropical agriculture in general, and containing several articles of interest in the first number, notably one by Professor Dunlop on Trinidad cacao, analyzing the causes of the present depression in that industry, and pointing out its need for an economic reconstruction. The references to cotton are few, and the only original one noticed is that the Department of Botany and Genetics at the college is endeavouring to isolate a new type of Egyptian Jannovitch. The publication may be recommended to readers interested in tropical agriculture.

MISCELLANEOUS NOTES

We regret to announce the death of two members of the Empire Cotton Growing Corporation:

Sir **Frank Hollins**, Bart., of Greyfriars, Preston, a Vice-President of the Corporation. Sir Frank Hollins was one of the leading figures in the cotton industry, and exercised considerable influence in all questions affecting Lancashire.

Mr. **Joshua Barber Lomax**, of Glenburn, Castle Street, Oldham. Mr. Barber Lomax was connected with a very large number of cotton-spinning and manufacturing concerns, and was a member of the Council and of the Executive Committee of the Corporation.

We offer our congratulations to Sir **William Clare Lees**, O.B.E., on receiving the honour of knighthood "for public and political services in Manchester." Sir William Clare Lees represents both Manchester Chamber of Commerce and the Bleachers' and Dyers' Association on the Council of the Corporation.

The Imperial College of Tropical Agriculture, Trinidad.—We much regret to learn from the *West India Committee Circular* of the impending retirement of Sir Francis Watts, Principal of the Imperial College of Tropical Agriculture. We quote the following from their issue of January 31, 1924:

"It is with sincere regret that we learn from Trinidad that Sir Francis Watts has announced his intention of retiring on reaching the age limit during the course of the year. The services of Sir Francis to West Indian agriculture, with which he has been connected since 1889, are too well known to need any words of ours. We predict a brilliant future for the college, but it must never be forgotten that the institution owed its sturdy infancy in no small measure to the fostering care and genius of Sir Francis Watts."

APPOINTMENTS.

South Africa.—In accordance with their offer to General Smuts to provide a small expert staff for the development of cotton growing in the Union of South Africa, the Corporation have appointed Mr. S. **Milligan** as their senior expert. Mr. Milligan has resigned his post of Agricultural Adviser to the Government of India in order to take up this work under the Corporation.

Mr. F. R. **Parnell**, M.A., has also been appointed as Plant Breeder, and will proceed to South Africa to work under Mr. Milligan.

Australia.—Mr. E. **Ballard** has been appointed by the Corporation as Cotton Entomologist, to be attached in the first instance to the Commonwealth Government of Australia.

OFFICERS ON LEAVE.

When an officer of a colonial Department of Agriculture (or of the allied departments of Irrigation, Transport, etc.) comes "home" on leave, he usually brings with him much information that may be of considerable value to similar officers in other colonies, or to the officers of the Empire Cotton Growing Corporation, who have to collect, collate, and use all possible information relating to cotton. The Corporation would consequently much appreciate the courtesy if Directors of Agriculture and others would be so kind as to inform them, in advance if possible, of the names, probable addresses, and approximate dates of arrival in England of officers coming on leave. This would give the Corporation the opportunity of getting into touch with these officers themselves, and of giving the latter the opportunity of meeting with one another. A further courtesy would be conferred if the officers themselves, upon arrival, would report at, or inform, the offices of the Empire Cotton Growing Corporation, which are at the corner of Millbank and Wood Street (entrance by the first door in Wood Street) immediately opposite to the offices of the Crown Agents for the Colonies.

At the date of writing the following officers are on leave in England:

Antigua	Mr. F. G. Harcourt.
Ceylon	Dr. J. C. Hutson.
,,	Mr. C. H. Gadd.
Gold Coast	Mr. W. H. Patterson.
Nigeria	Mr. A. R. Bell.
Sierra Leone	Mr. M. T. Dawe.
Tanganyika Territory	Mr. L. C. Edwards.
,, ,,	Mr. A. H. Ritchie.
,, ,,	Mr. O. E. Whitehead.
,, ,,	Mr. E. Brand.
Uganda	Mr. D. T. Maitland.

SPINNING TESTS.

The Corporation have been able to arrange for spinning tests to be carried out on samples of cotton from the different countries of the Empire, and Directors of Agriculture have been invited to submit any samples that they would like examined and tested. It is hoped that these tests may provide information of especial value to those engaged on the improvement of the crop by selection work.

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THE
EMPIRE COTTON GROWING
REVIEW

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COTTON GROWING WITHIN THE BRITISH EMPIRE—I*

BY
L. G. KILLBY
Secretary to the Empire Cotton Growing Corporation.

Two years ago a paper was presented under this title to the International Cotton Congress then meeting at Stöckholm. An account was then given of the steps that had led to the formation of the Empire Cotton Growing Corporation, a body depending for its resources alike upon the British Government and the spinners of Great Britain. A short summary was given of the Corporation's organization, and the general lines upon which work would be undertaken were foreshadowed.

It is intended in the present paper to give some indications of the conclusions which the Corporation have so far reached as to the general means whereby their object will best be attained, the action taken by them as the result of those conclusions, and, finally, a brief review of the present position and future prospects of the cotton-growing industry in the several Dominions and Dependencies of the British Empire.

The problems of cotton-growing all fall into one of two categories, being those either of farming in its widest sense, or of bringing the crop to market. Taking the latter category first, it is in the matters of transport and marketing that the Home and Local Governments can give invaluable assistance in developing new cotton lands.

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* The following paper was prepared for the meeting of the International Cotton Congress that was fixed to be held in Vienna last month, but which had to be postponed. It has consequently been decided to print the paper in the Corporation's Journal in the belief that the summary which it contains of the present position of cotton-growing in the several countries of the Empire may be found useful by some readers. It will be completed in October.

Transport is of primary importance, and if the supply of cotton is to develop at all rapidly it is to be hoped that the Governments of all potential cotton-growing countries will not adopt too cautious a policy in this respect, but will embark on a scheme for improving communications by rail, road, or water, wherever it seems reasonable to conclude that they will prove remunerative propositions ultimately if not immediately. The extension of cotton-growing areas without the previous, or simultaneous, provision of an efficient means of bringing the crop out of the country, is not merely extremely difficult, but can lead to no substantial or permanent results, whereas the agricultural development of a country proceeds apace when once a railway has been laid and feeder roads constructed.

In most parts of the British Empire, and particularly in tropical Africa, there is need of more and better communications—railways, bridges, roads and water transport. The method of head porterage, still the only form of transport possible in many parts, is obviously wasteful in that a man is of far greater economic value as an agricultural labourer producing crops than when acting as a beast of burden. Nor can this matter of the provision of new means of transport be left mainly to private enterprise. A new railway, for example, will open up new country, but cannot become a paying proposition until the country through which it passes has been cleared and cultivated or its mineral wealth developed—a period of some few years at least. It may be accepted as a general principle, therefore, that it is from the Imperial Treasury, or from those of the local Governments, that funds must as a rule be provided for the construction of railways, roads, irrigation and harbour works. A few instances may perhaps be given of the readiness with which the British and Overseas Governments have accepted their responsibility in this respect in their cotton-growing areas:—

The Imperial Government have lately sanctioned a grant of assistance towards the extension of the Uganda Railway to a point near Jinja from Nakuru, a station on the main line between Mombasa and Kisumu, which is directly intended to develop the cotton-growing industry of Uganda and to open up the important country of North Kavirondo, where cotton should be grown in large amount. It may be mentioned parenthetically that the case of Uganda affords an instance of the full development of a country awaiting the provision of adequate transport. As regards the Tanganyika Territory, proposals are under consideration for the construction of a railway from Tabora to the important cotton-growing district of Mwanza and for the reconditioning and extension of the Lindi

Tramway, which taps an important cotton-growing area. The Imperial Government have guaranteed the loans required by the Sudan Government to complete the great dam on the Blue Nile and to construct the Kassala Railway; it has recently been announced that in order to develop the promising cotton-growing country in Natal and Zululand, the Union Government have decided to extend the railway northwards from Somkele to the Pongola River. In these cases the railways will presumably not be self-supporting during the first few years, but the Governments concerned have adopted a far-sighted policy in that they have recognized that development must be slow and uncertain until the railways are constructed in anticipation of the countries' future requirements. Under the section devoted to India in this paper, mention is made of the vast irrigation scheme on the Indus, which will cost the Government of India over 12 millions sterling, while a similar project, though on a smaller scale, is under construction in the Punjab on the River Sutlej. As regards harbour works, mention may be made of the large sums spent by the Sudan Government upon Port Sudan, which have resulted in making it one of the most up-to-date harbours of the world. The Government of Kenya also are, in connection with the scheme which is being assisted by the Imperial Government, providing for the extension of the wharves of Kilindini Harbour, so as to render it more capable of dealing with the rapidly increasing export trade passing down the Uganda Railway.

Enough has been said on this head to illustrate the fact that the Imperial and local Governments are fully alive to the vital necessity of developing, by means of public works, those countries whose prosperity is so largely dependent on the cultivation, for export, of tropical agricultural products, of which cotton is in many cases the most important.

That in many countries, and especially in tropical Africa, transport is often the limiting factor to the development, is a view held strongly by the Corporation, and they have made urgent representations to this effect to the Imperial Government. It is gratifying to report that their representations have always been received most sympathetically, and have been followed by developments in railway extension work, including some of those that have just been mentioned.

As regards the marketing of cotton, assistance has been given both by local Governments and by bodies such as the British Cotton Growing Association. In Australia the Queensland Government decided that, in order that farmers should be induced to plant cotton, it was necessary that they should be assured of a market for their produce at a price at which its cultivation would show a profit, and that such help should be given for the next few years, so that the industry might become fairly established. All cotton is therefore bought by the Government at a price guaranteed over a period of years. Further details of the arrangement are given under the section dealing with Australia. The arguments in favour of a guaranteed price are more convincing perhaps where cotton cultivation is in the hands of native races who are slower to grasp the inevitability of fluctuations in the market, and in this direction the action of the British Cotton Growing Association, in guaranteeing a price at the beginning of each season in Nigeria and in Nyasaland, has proved a valuable stimulus to increasing the popularity of cotton cultivation among the natives of those two countries. Nigerian buying has now been thrown open, as it is considered that the industry is firmly established.

In all the colonies and protectorates of Africa in which cotton is grown by natives, its sale is organized to a greater or less degree by the local Government. In some countries, such as Uganda, the crop may either be offered for sale at a ginnery or be brought to prescribed markets, where it is sold by open competition among merchants and ginners; in others, such as Tanganyika, it is frequently sold by auction. But, whichever course be adopted, the market is held under the superintendence of the officers of the Agricultural Department, whose duty it is to see that no abuses exist the effect of which would be to cheat the native grower of a fair price for his produce.

Turning now to the other type of the problems of cotton-growing, which are those relating to its cultivation, we again find the Governments taking an active part and lending a helping hand wherever it is needed. In all countries legislation is in force to ensure that all imported seed is free from insect pests and disease; in many, also, the distribution of seed is in the hands of the Agricultural Departments themselves, or of agents authorized by them for this purpose. Those Departments, moreover, in co-operation with the political officers, carry on propaganda work to popularize cotton-growing, and their officers, either directly or through trained native instructors, are constantly ready with advice on its proper cultivation and on the treatment of any disease or pest to which the crop may fall a prey. It will readily be seen, therefore, that if cotton-growing is to be increased effectively a first essential is that the Agricultural Departments should be staffed with a sufficient number of suitably trained men. Everywhere there is a need of more experimental work, more demonstration, more training of those engaged in growing cotton. And this deficiency is not due wholly to the insufficiency of the funds at the disposal of the local Governments: there has also been a lack of provision of facilities for giving men the specialized training that is required to enable them to deal with the specific problems of cotton cultivation. Credit may be claimed by the Empire Cotton Growing Corporation for having made the increase of the supply of adequately trained men for the Agricultural Departments one of their first objectives. It was decided to offer each year a number of Studentships for advanced training in the botanical sciences or in agriculture. These have been increased in number each year, while the opening in October, 1922, of the Imperial College of Tropical Agriculture in Trinidad provided means whereby a certain proportion of these students can receive a practical training in tropical agriculture before entering service in the cotton-growing countries. Full advantage has been taken by the Corporation of this opportunity; a grant of £500 a year has been made to the college, and four of its post-graduate students are now taking a special course in Trinidad under its professors.

To enable the Agricultural Departments to enlarge their staffs by the employment of such men, the Corporation have intimated their willingness to make grants to the local Governments to be devoted to such further work in connection with cotton-growing as they would be unable to carry out with their own unaided resources. In many Colonies, until the agricultural staffs are considerably strengthened both as to the number and the qualifications of their personnel, this will remain the limiting factor in the output of cotton. More trained European staff means not only more direct personal supervision, but, where the cultivators are natives, more trained native instructors also, so that correct agricultural methods in cotton cultivation may be demonstrated in all suitable parts of the Dependencies. Where a cotton-growing Dependency is willing to produce side by side with its agricultural estimates a supplementary budget showing what further cotton work, in addition to that which it is prepared to do unaided, can be put in hand if the Corporation will make a grant to enable the staff to be increased or the scope of the work enlarged, the Corporation consider that this is one of the directions in which their funds can be most usefully employed as a means of directly leading to an increase in production and an improvement in quality.

Another direction in which the help of the Corporation was urgently sought from the outset was the provision of senior men with long experience of cotton-growing, whose services might be loaned by the Corporation to the local Governments in proved cotton-growing countries. Such men are phenomenally scarce, and the Corporation consider themselves fortunate in having been able to secure the services of four exceptionally able officers who have joined their staff, or have been temporarily borrowed, from the Indian Agricultural Service. Three of these have already been appointed as Cotton Specialists in Nyasaland, Queensland and Tanganyika respectively, while a fourth is leaving shortly for South Africa, where he will advise the Union Government on all matters affecting cotton-growing and marketing.

Another matter which has received the close attention of the Corporation is the need for research on fundamental problems underlying the cultivation of cotton and the properties of the fibre. The latter are mainly occupying the energies of the staff of the British Cotton Industry Research Association, but, in addition, there is an immense field of research to be worked in the actual growing of cotton, the study of the life of the plant in health and disease, and the effects of heredity by which its constitution is determined and can be controlled. Such problems as these can probably be best worked out at a Research Institute in a cotton-growing country, and the Corporation have appointed a special committee to consider the advisability of establishing such an institute and, in the event of their recommending it, to report as to where it should be placed and with what staff it should be equipped. In the meantime the Corporation have felt that it was necessary that agriculturists abroad should be able to refer, for investigation by scientists at home, problems for the elucidation of which they have themselves neither the time, facilities, nor frequently the special qualifications. To meet this need grants of £1,000 a year for five years have been made to the Imperial College of Science in London, the School of Agriculture at Cambridge, the Agricultural Experiment Station at Rothamsted, and the Botanical Department of the University of Manchester. At each of these Institutions the services of a specialist have been retained who will devote his time to the special study of those aspects of Plant Physiology and Pathology, Genetics, Soil Physics, Mycology and Entomology respectively which are of especial importance in cotton-growing, and he will deal with applications for advice from agriculturists and botanists in cotton-growing countries.

In all matters relating to research work the Corporation attach importance to the maintenance of close touch with the British Cotton Industry Research Association. Already arrangements have been made whereby the latter body have kindly agreed to allow the Corporation's post-graduate students to spend a short time at the Research Association's laboratories in order that they may gain a general knowledge of the types of problems that are being investigated there. In the event of the Corporation deciding to establish a Research Institute abroad it is hoped that its staff and the botanical staff of the Research Association in this country will be practically interchangeable, so that the Corporation's workers would be able to carry out at home research on problems that have arisen abroad, but which could be more conveniently worked out under non-tropical conditions, while the staff of the Research Association would be able to put to the test under field conditions results obtained by them in the greenhouse and the laboratory in England. A small co-ordinating committee of the two bodies has been set up to deal with matters of common interest, and this body has recently discussed the steps that can be taken to submit to suitable spinning tests samples of cottons produced by the selection work that is being carried out in different parts of the Empire either by the Corporation's Cotton Specialists or by the staffs of the Government Departments of Agriculture.

It is one of the aims of the Corporation to collect and disseminate knowledge of all matters of interest to scientific and other growers of cotton, and to make growers and spinners more familiar than they are at present with one another's requirements and the difficulties with which each is faced. With this object a quarterly journal has been started under the title of *The Empire Cotton Growing Review*, the first number of which was issued in January of this year. It is hoped to include in the journal not only information as to the activities of the Corporation, so that spinners and growers may be kept in touch with the work that is going on, but also to publish articles on cotton-growing problems from all parts of the Empire, and thus to keep Directors of Agriculture and others in touch with the experiments that are being conducted, and the development that is taking place in the several Dominions and Colonies. Much of this information may not be of the nature of original contributions, but must be derived from Government reports, and agricultural, technical and trade journals. It is hoped, however, that its presentation in one publication will be convenient, and may serve to bring under the notice, especially of workers abroad, information that they are glad to have and might otherwise have missed. It is hoped, moreover, that the circulation of the journal among spinners will add to their knowledge of the lives and experiences of those on whom they are dependent for the supply of their raw material, and the conditions under which it is grown. At the same time, articles dealing with the problems of the spinning industry should be both interesting and helpful to growers, for although the latter are naturally aware that they grow cotton in order that it may be spun, they are only too seldom familiar with any of the processes through which their cotton passes in the spinning mills, and have as a rule but a vague knowledge of what is implied by the empirical, but perhaps the most useful, definition of good cotton as being that which makes good yarn.

The quantity of cotton produced in all parts of the Empire except India is at present only very small, say 180,000 bales. But from one point of view this fact is not wholly to be deplored, since in some ways it simplifies the task of those whose desire it is to ensure that from the start a great industry shall be built up on sound foundations. Some details given below of the difficulties encountered in India, where a Cotton Committee is at work on lines similar to, but naturally narrower than, those of the Corporation, show how other parts of the Empire may learn from their experience. The problems confronting that Committee at the outset of their work, such as wilful admixture of cottons of different types, mercifully do not bulk so largely in countries where cotton-growing is still in its infancy. If, therefore, the industry can be planned from its inception on sound scientific principles, and kept on the right lines by the encouragement and supervision of the local Governments who are determined to make the export of cotton of good quality one of their leading highroads to prosperity, there is every reason to hope that the Corporation, by the adoption of a far-sighted policy carried through with unremitting energy, will play an important part in enabling the Empire to make a notable contribution to the world's cotton crops.

A brief account follows of the present position of cotton-growing in all the chief producing centres in the Empire.

INDIA.

It is clear that in a paper such as this, which aims at giving a brief but comprehensive survey of cotton production in all parts of the British Empire, space precludes justice being done to India, whose cotton production is second only to that of America of all the countries of the world.

For the years 1918-22 the average Indian crop exceeded 4½ million bales, and it now amounts to 24 per cent. of the world's cotton. It is not unnatural, therefore, that it is to India that attention should be turned as offering the most speedy solution of the difficulty of making up the shortage caused by the decrease of supplies from America. But, unfortunately, the greater part of the cotton produced by India is too short in staple to be of service to replace American cotton, and though improvement in the staple is one of the problems that is engaging the earnest attention of the Indian Central Cotton Committee, there are many difficulties to be overcome. Firstly, the actual growing season is short—an important consideration, for in general the longer-stapled cottons mature less rapidly than the short-stapled. The shortness of the season is due to two main causes: in the rainfall areas the rains are not always well distributed, and in case of shortage the soil does not retain sufficient moisture to bring the plant to maturity; in the irrigation areas in the north there is risk of frosts during the later stage of development. In all parts, moreover, the risk of damage from blight or other causes naturally increases with the duration of the crop. Secondly, among the native cultivators short-stapled cottons are more popular as giving heavier yields per acre, and being generally less troublesome to grow; while, thirdly, the prevalence of adulteration by mixing short staple in with long staple by ginners and middlemen gives the grower but little assurance that he will receive a higher price for his better cotton should he be persuaded to try it. This is a factor in the situation which received very early attention at the hands of the Indian Central Cotton Committee, and on their recommendation legislation has been passed by which inferior cottons will be debarred entrance into areas where long-stapled cottons are grown and ginned. Further legislation is contemplated which requires the compulsory marking of bales at the presses so that adulteration may be more readily traced. So far as concerns land already under cultivation, an increase in the production of uniform longer-stapled cotton can only be secured gradually by hybridization and other measures of improvement in the types at present grown, with a view to increasing their yield, while at the same time opportunities for admixture of seed should be reduced to a minimum.

An important scheme for the production of longer-stapled cotton is that of the B.C.G.A. (Punjab), Ltd., at Khanewal. The Company own an estate of about 7,300 acres, of which about 1.900 acres are under cotton. Of these about 1,300 acres are American cotton, having a staple of 1 inch to $1\frac{3}{16}$ inches. Desi cotton is also grown, and although the staple is only about $\frac{1}{2}$ inch it is a strong competitor with the American types among growers, in spite of its lower value, by reason of its higher yield and superior ginning outturn. The land on the estate is divided into 25-acre blocks, and leased to tenants, and there are more applicants than there are plots to be leased.

Greatly increased cotton production may be looked for as the result of the important irrigation schemes now being undertaken, which are ample evidence of the benefits that India is experiencing from British rule. Already, in the Punjab, the area under irrigation is over 10 million acres, while another scheme is under construction by which a great additional acreage will be irrigated from the River Sutlej. At the present time, of the total cropped area in the Punjab nearly one-half is irrigated by canals, wells or other sources. Of other recent undertakings by far the most important is the Lloyd barrage of the Indus in Sind, of which the Governor of Bombay at the time, Sir George Lloyd, laid the foundation-stone in October last. This vast scheme, which will cost over 12 millions sterling, will bring under cultivation an area greater than that under cultivation in the whole of Egypt. Of this over three-quarters of a million acres should be cotton land, and on this area, the soil being good and the climate satisfactory, it should be possible to grow cotton of the best American types. In the Deccan also important irrigation schemes have recently come into operation. In Madras the Cauvery Reservoir project will not only safeguard the Cauvery delta, but will bring much new land under cultivation. In the United Provinces the work of constructing the great Sarda Canal scheme is in active progress. Of the area commanded about $1\frac{3}{4}$ million acres will be irrigated.

From what has been said it will be seen that means are being provided whereby India will ultimately be enabled to make important contributions to the resources of the Empire in longer-stapled cottons, but the programme of work that is being so energetically undertaken by the Indian Central Cotton Committee gives ground for the hope that it may be unnecessary to await the development of these irrigation projects before such an improvement will be effected in the present methods of cultivation, and in the types grown, that the output of improved cotton will be notably increased, and the belief has been expressed that within five years India's crop should reach 6 million bales, of which 2 million should have a staple of $1\frac{1}{16}$ to $1\frac{1}{8}$ inches. Such an advance would go far towards relieving the present dependence of the world on America for cotton of this staple. To achieve such a result further research work is needed in order to produce still earlier maturing varieties with a higher yield; moreover, means must be at hand for dealing with pests and diseases, since the exotic types are usually less immune than the indigenous varieties. Furthermore, the legislation to prevent mixing must be effective, so that the grower of improved cottons may be assured of an enhanced price for his superior produce.

At the present time the Empire Cotton Growing Corporation is co-operating with the Indian Committee with a view to developing a market for Indian cottons in Lancashire. Six varieties, already well known on the Liverpool market, are being subjected to commercial spinning tests, so that their actual spinning qualities and their percentages of waste under normal conditions may be accurately known. The raw cottons and the yarns produced from them will, it is hoped, be exhibited in Lancashire, together with the results of the tests made on each. Bales of other types believed to be suitable to Lancashire's requirements are also on their way from India, and it is hoped to deal with these similarly. By this means spinners will be made more fully aware of the merits of India's better types of cotton, and it is hoped that the result will be apparent in their increased consumption, so that as their supply develops they may be at once absorbed, and encouragement thus afforded to increased production.

AUSTRALIA.

During the past few years the subject of cotton-growing on a large scale has been taken up with remarkable enthusiasm, especially in Queensland. There are undoubtedly very large areas in Australia, particularly in Queensland, and to a smaller extent in New South Wales, where both soil and climate are well suited to cotton. The prospects of any great extension in a short time are, however, limited by the present lack of labour, its quality, and its cost. Australian statesmen are convinced that their cotton grown on the basis of white labour can compete in the world's markets. The quality of the cotton is satisfactory, and if the Australian Government's view proves correct, that continent should be able in the future to make a considerable addition to the world's cotton supplies.

The Empire Cotton Growing Corporation have gladly rendered what help they could. They secured a year ago the services of Mr. G. Evans, formerly Director of Agriculture, Bengal, and lent them to the Queensland Government for a period of three years.

It is gratifying to record that Mr. Evans has been of the greatest help to the Government, who have made him Director of Cotton Culture in that State.

In Queensland alone the acreage under cotton has increased more than ten times in the past three years. Last season, 1922-23, 7,863 bales of 500 lbs. each were produced, and for the season 1923-24, it is estimated that over 100,000 acres have been planted. The Government fully realize the importance of securing an adequate supply of uniform seed, and Government seed farms are being started. Experiments made so far have gone to show that the same seed may not be the best for all parts of the State, since both the soil and the rainfall are different on the coast from what they are further inland; it is intended, therefore, to have several seed farms, and to grow in each only that variety which is best suited to the district which it serves. The most generally successful variety up to the present has been Durango. But the seed has hitherto consisted largely of a mixture of several types of American Upland, together with some Sea Island and Egyptian, and the Government are consequently doing their utmost to encourage the foundation of the industry on a " one-variety " or " community " basis, whereby each district will grow only the type best suited to its own conditions. This scheme can only develop fully, however, when the selection and multiplication work at the several seed farms has proceeded far enough to produce a sufficiency of each kind of seed required for the different districts.

The industry is entirely controlled by the Government, and the measures taken to develop and encourage the industry are set out in the Cotton Industry Act, which became law early this year. Its provisions cannot be quoted fully in this paper, but it may be mentioned that (1) the Government takes power to acquire all cotton grown in the State at a price which this year is 5½d. per lb. of seed cotton for good quality cotton of 1¼ inches staple, and falls to 4d. per lb. for good cotton under 1⅛ inches staple; (2) no seed may be sown other than that supplied by the Department of Agriculture; (3) no ratoon cotton may be grown; (4) all cotton plants shall be destroyed by a fixed date every year. Considerable protest against the prohibition of ratoon cotton has been made by a small but vocal section among the growers. The Government has, however, maintained its uncompromising attitude, giving as its reasons the deterioration in quality shown by ratoon cotton, and the danger caused by its tendency to harbour pests. In an attempt to disarm its critics it is even going so far as to have samples of ratoon cotton examined in the laboratories of the British Cotton Industry Research Association and subjected to commercial spinning tests, while field tests against annual cotton are also being conducted. The Government has appointed an official grader selected by the Corporation at its request, and he is also training a staff of assistants.

As regards insect pests, neither the Mexican boll-weevil nor the pink boll-worm have as yet appeared in Queensland, but the northern peach moth, the rough boll-worm, and the maize moth do serious harm. The first-named does the worst injury, for it not only pierces the bolls and thus damages by its own action, but it permits the entry of the spores of a fungus which produces internal boll rot. The Corporation made an offer to the Commonwealth Government to appoint and pay the salary of an experienced cotton entomologist, and this offer has been accepted. The entomologist appointed sailed for Australia in February; he has been attached to the Commonwealth Government rather than to that of any one of the States, since his duties will probably necessitate his travelling in all parts of the continent, though the greater part of his work will be in Queensland.

Apart from Queensland, Mr. Evans has visited New South Wales, Western Australia, and the Northern Territory. In none of these is cotton-growing yet carried on extensively, but in New South Wales particularly it is being taken up with enthusiasm, and it is estimated that several thousand acres will be planted this year. The local Government have guaranteed a price and made with the British Australian Cotton Association an arrangement to gin, ship, and market all the cotton grown in this State, similar in terms to that made with the Association by the Queensland Government.

In both Western Australia and the Northern Territory pink boll-worm has been identified. To prevent risk of the pest being introduced into Queensland, arrangements have been made for all cotton grown in both areas to be ginned only at Port Darwin, where a new ginnery is being erected for the purpose.

In all States important schemes are under construction for growing cotton under irrigation both by itself and with fruit.

What has been said will suffice to show that Australia is making determined efforts to establish a cotton-growing industry. Its success on a large scale would appear to depend on three factors—(*a*) a sufficient supply of labour at a reasonable cost; (*b*) the maintenance of good quality; (*c*) the continuance of the price of middling American at not less than 1s. per lb., though a slightly lower price may still enable it to be grown at a profit, as increased experience and improved organization is sure to lower the cost of production. It has already been recognized in Queensland that the best method is to include on a mixed farm only such an acreage of cotton as can be picked by a man and his family with little or no hired labour, and it is, therefore, a gratifying feature that the average holding this season is not more than 12 acres per farmer.

SOUTH AFRICA.

It has long been recognized that cotton of good quality could be grown in South Africa, but it is only of late years that development has been at all marked. Hitherto a defect in the lint has been its varied lengths of staple, due to mixed seed and absence of expert grading. Latterly, however, the Union Government, in combination with private enterprise, have taken up the industry wholeheartedly in the earnest desire to extend the cultivation of the crop in all suitable parts of South Africa to the fullest possible extent.

In order to gain first-hand knowledge of the country's possibilities as a potential cotton producer, the Corporation sent out Mr. G. F. Keatinge, C.I.E., to make a tour of the country. This he did between November, 1922, and March, 1923, and his report has been most carefully considered by the Corporation, who reached the following important conclusions—(*a*) that South Africa had very great possibilities as a cotton-growing country, and that the efforts that were being made to develop it should have their fullest support; (*b*) that the expert technical staff then at the disposal of the Union Government was not numerically strong enough to deal with the large and particularly varied areas in which cotton-growing is commercially possible; (*c*) that improved communications are essential.

The next step was taken while General Smuts, Prime Minister of South Africa, was in England in October last. A deputation from the Corporation laid before him the conclusions they had formed, and explained the reasons on which they were based. They offered to obtain and pay the salary of the most experienced expert they could find to advise the Union Government on all matters relating to cotton growing and marketing, and to attach to him a small but highly qualified staff. This offer was promptly and gladly accepted by General Smuts on behalf of his Government, and the Corporation consider themselves particularly fortunate in having been able to engage the services of Mr. S. Milligan, who has resigned his position as Agricultural Adviser to the Government of

India to go to South Africa as the Corporation's expert. Mr. Milligan is being accompanied by an experienced plant breeder, and the Corporation would be prepared to add to his staff, if he considers it necessary. The specialized scientific work that will immediately confront these experts will consist doubtless in co-operating with the Department of Agriculture in producing and distributing a supply of pure seed, so as to render the South African type as uniform as possible.

To ensure a ready market, the length of staple should be $1\frac{1}{8}$ to $1\frac{3}{16}$ inches, preferably the latter, so as to allow of some deterioration and still give the farmer a product that will be marketable at a premium over middling American. The Department of Agriculture is already conducting its research work, in close conjunction with the botanical and agricultural faculties of the Transvaal University College.

With regard to communications, the Corporation expressed to General Smuts their opinion that the most effectual immediate stimulus would be given by the extension of the existing railway in Natal northwards from Somkele, the present terminus, to the Pongola River. This extension would open up a country in which much cotton is already being produced, but which is capable of remarkable developments when the necessary transport is provided. The Prime Minister undertook to give the suggestion most careful consideration, and since his return to South Africa he has announced that the Government will construct the extension as suggested. Mr. Keatinge reported that the whole of the country northwards to Komatipoort should prove suitable for cotton, and it is to be hoped, therefore, that it may be found possible before long to continue the new railway to the north, thus opening up the fertile country on the west of the Lebombo Mountains. The railway immediately contemplated—viz., Somkele to the Pongola River—will traverse Zululand, and already the Government are developing the Crown lands there; an extensive survey is being undertaken, farms are being laid out, and experimental farms are being planned.

Among other steps taken by the Government with a view to organizing the rapidly growing industry on sound lines may be mentioned the passing of a law requiring all cotton to be pressed to a uniform density, and standardizing the bale at 500 lbs. All ginneries must be registered, and all cotton for export must be graded by a Government grader, and the type mark awarded by the grader, together with the ginner's mark, must be placed on each bale. A charge of 1s. per bale is made for grading. There is also a special levy of 1s. per 100 lbs. of lint exported; the proceeds of the levy are ear-marked for the furtherance of the cotton industry.

Reference has only been made so far to the possibilities of Natal and Zululand, but the cotton belt in South Africa extends also northwestwards from Komatipoort through Leydsdorp, Tzaneen, and Spelonken to the Zoutpansberg Mountains, while to the west of these, and north of Pretoria, lie the Rustenburg and Waterberg areas, where cotton has for many years been, and is still being, grown in increasing quantities. The railway from Rustenberg to Pretoria and the line eastwards to Komatipoort, tap the areas of Nelspruit, Barberton, and Malelane, where cotton is being grown. There is also already a railway to convey the produce of the Spelonken, Leydsdorp, and Tzaneen areas to Komatipoort, from which point to the northern limit of the cotton belt the distance is about 250 miles.

All the above areas are, and will be, developed by white settlers working with native labour. The question of promoting an industry of cotton-growing by natives on their own small holdings was discussed with General Smuts, and his view was that it was preferable first to educate the natives in sound cultural methods on existing farms before encouraging them to take up cotton in the native reserves. The Administration of the Transkei would welcome the introduction of a profitable cash crop for the natives, but thorough experimental work would first be necessary to establish definitely which type is best suited to the district, because failures due to insufficient knowledge would cause general discouragement.

Taking the country as a whole, the Agricultural Department estimates the average yield at 200 lbs. of lint per acre.

The South African crop has increased from 764,584 lbs. of lint in 1918-19 to 2,400,000 lbs. in 1922-23. In order to cope with this rapid expansion an organization is needed to assist in the financing and marketing of the crop. There are already a number of local co-operative associations of farmers, and two years ago a Central Co-operative Cotton Exchange was formed as an unlimited co-operative society whose objects included the grading, pooling, and marketing of cotton, and the negotiations of loans on the crops of the smaller growers to enable them to meet the costs of harvesting and transport. This body has been unable to function fully, however, owing to the fact that it received only the partial support of the growers. In these circumstances it seems probable that the efforts of the Government to make cotton one of the most important crops in South

Africa will only become fully successful if they are able to lay down a policy including a scheme to provide general ginning, marketing, and financial facilities, in order that the industry may be in a position to compete with other cotton-growing parts of the world where it is already highly organized. The Corporation invited General Smuts to consider this point on his return, and promised their support in so far as it could be given from this country, though it is felt that any such scheme must be pre-eminently South African in its management.

SOUTHERN RHODESIA.

Southern Rhodesia is now a self-supporting Colony, with its own separate administration and its own Department of Agriculture. It is understood that the Government is anxious to develop cotton cultivation if it is found to be possible under the climatic conditions of the country, but the reports which the Corporation have hitherto received as to the possibilities for cotton production have been somewhat conflicting.

With a view to ascertaining the chances of success in this country, the Corporation are endeavouring to find an expert to report upon the suitability of the districts that have a sufficient and dependable rainfall. If it is decided that there are prospects of considerable production the expert would remain in order to advise the Agricultural Department and settlers on matters relating to cotton. A certain amount of cotton has been grown in Southern Rhodesia for some years, but the industry has not so far developed on extensive lines.

It was reported in January last that tenders had been invited for a ginnery to be erected at Salisbury, and it was stated that the machinery would be ready in time to deal with the crop planted in November and December last. If this crop is a success a considerable increase in the acreage under cotton may be expected this autumn. Several farmers are giving cotton growing a trial, and the staff of the Agricultural Department have issued full details on the cultivation of the crop.

(*To be continued.*)

AN ACCOUNT OF A TOUR THROUGH PORTIONS OF THE COTTON BELT OF AMERICA

BY

H. C. SAMPSON, C.I.E.

Cotton Specialist, Nyasaland.

As is natural under present conditions of cotton production in America, the experimental work throughout the cotton belt is largely connected with the production of cotton under boll-weevil conditions. This work can be divided under four heads: (1) The breeding of early varieties which will mature a crop of cotton before the weevil has multiplied sufficiently to cause serious damage. (2) The study of methods of crop management and manuring which will hasten the ripening of the crop. (3) Investigation into the life history of the pest, especially in connection with its hibernation. (4) The study of methods of controlling the increase of the weevil during the growing season.

The first sight that I had of cotton was from the train travelling through Tennessee to Memphis, and I was at once struck by the difference in the appearance of the crop from that to which I have been accustomed, both in India and Africa. Though the cotton was already bursting the plants looked remarkably fresh and green—even the main leaves on the stem, which in warmer and drier countries invariably shed or dry up by the time the crop commences to ripen. This impression of the appearance of the crop was confirmed subsequently in every State that I visited, and may be the reason why, in America, little attention has in the past been paid to the hairiness and texture of the leaf when selecting cotton for seed. It may also explain why it is that varieties of cotton from the U.S.A. so frequently fail when tried in warmer and drier climates.

The first place that I visited was the Delta and Pinelands Plantations at Scott, Miss. This I was enabled to do through the courtesy of Mr. Howarth and of Mr. Salsbury, the President. I stayed a week here, most of my time being spent with Mr. Ewing, the plant breeder and agronomist employed by the company. Much of my time was spent on his experimental area, examining the varieties of cotton which he had under test and the new strains which he had produced either by selection or by cross-pollination. I also saw over a large part of the estates either with Mr. Ewing or with Professor Fox, the General Manager of the plantations, and more particularly those parts where new strains produced by Mr. Ewing were being grown on a field scale. I was very much impressed by the efficient manner in which these plantations, which are claimed to be the largest in the world, were run. Everything that could be done to control the weevil was done. Nitrate of soda, which the experimental work on the station had shown to be the best means of hastening the maturity of the crop, had everywhere been applied, while, whenever the weather was favourable for dusting the crops with calcium arsenate, this was being done. Unfortunately, the season had not been favourable to this method of control owing to the continuous rains, which not only favoured the increase of the pest, but stopped all measures that might have been taken to control it.

One point of rather serious import in connection with the control of the weevil by dusting with calcium arsenate was the bad attack of aphis which frequently followed such treatment. There is no doubt that the poison not only kills the weevil, but also the natural enemies of the aphis which would normally keep the latter under control. It is more than probable also that it destroys many of the insect-feeding birds which help to keep insect damage under control. The army worm, which was very abundant, proved, in cases where the crop was well forward, a blessing in disguise, as it entirely defoliated many of the crops and thus allowed the sun to reach the bolls. Where the foliage had not been destroyed much of the cotton on the lower branches was rotting during this rainy weather. I found Mr. Ewing's breeding work extraordinarily interesting, and obtained seed of several of his strains which seemed to me likely to offer success under the conditions which prevail in Nyasaland.

The next place that I visited after leaving Scott was the U.S.A. Cotton-Breeding Station at Greenville, Texas. Unfortunately, Mr. MacNamara, the Superintendent, and his chief assistant, who is in charge of the plant-breeding work, were away on tour in the south of the State, and there was no prospect of their returning during the time which I could spare at this station. However, I was able to see much of the experimental work in progress with the help of the staff left on the station. Here boll-weevil problems occupied a large amount of the work in progress. The two chief varieties of cotton under cultivation were Lone Star and Acala, and most of the plant-breeding work was connected with these. Both of these, however, are smooth-leaved varieties and are unsuitable, in my opinion, to the conditions which prevail in Nyasaland. Both are fairly short stapled cottons which yield a very high percentage of lint. Much of the experimental work is connected with cultural experiments, chiefly thinning and spacing. Here the experience has been that the best yields per acre under weevil conditions are obtained by not thinning at all. The individual plants remain small and possibly give one or two bolls each. It is the aggregate number of bolls which can form early in the season which give the acre yield. The soil conditions here, however, are peculiar to this part of the State, and these results cannot be taken as of general application. The soil very closely resembles the black cotton soils of India, and cotton growing on such soils naturally tends to be dwarfed. It is quite possible that this closely grown dwarfed cotton would give still greater yields if grown in 3-foot instead of 4-foot rows. There was a series of plant-to-row cotton variety tests made with seed supplied by the U.S.A. Department of Agriculture. Their interest to me lay mainly in the fact that the same series was being grown at experimental stations in each of the cotton States, and it was interesting to observe how the same varieties varied in habit under different conditions of soil and climate. It is also interesting to note that in most places where I subsequently saw these varieties, it was usually the main local variety which gave the best yields. It is possible that if these varieties had been acclimatized in each locality, different results would have been obtained.

From Greenville I next visited the Georgia State Experiment Station at Griffen, where several of the local varieties were being tested. The season—or at any rate the latter part of it—here had been very dry, and this was the only place visited where cotton showed signs of shedding its main leaves before the crop was ready for picking. I selected three or four varieties here which seemed to withstand these conditions best, and obtained a small quantity of seed from each. The manurial experiments here were interesting. Nitrogen, phosphates, and potash had been applied in varying quantities. Taking 5 as the total quantity of manure applied, duplicate plots of every combination had been laid down thus:

N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
5	0	0	2	1	2	1	0	4
4	1	0	2	3	0	0	2	3
4	0	1	2	0	3	0	3	2
3	1	1	1	2	2	0	1	4
3	2	0	1	3	1	0	4	1
3	0	2	1	1	3	0	5	0
2	2	1	1	4	0	0	0	5

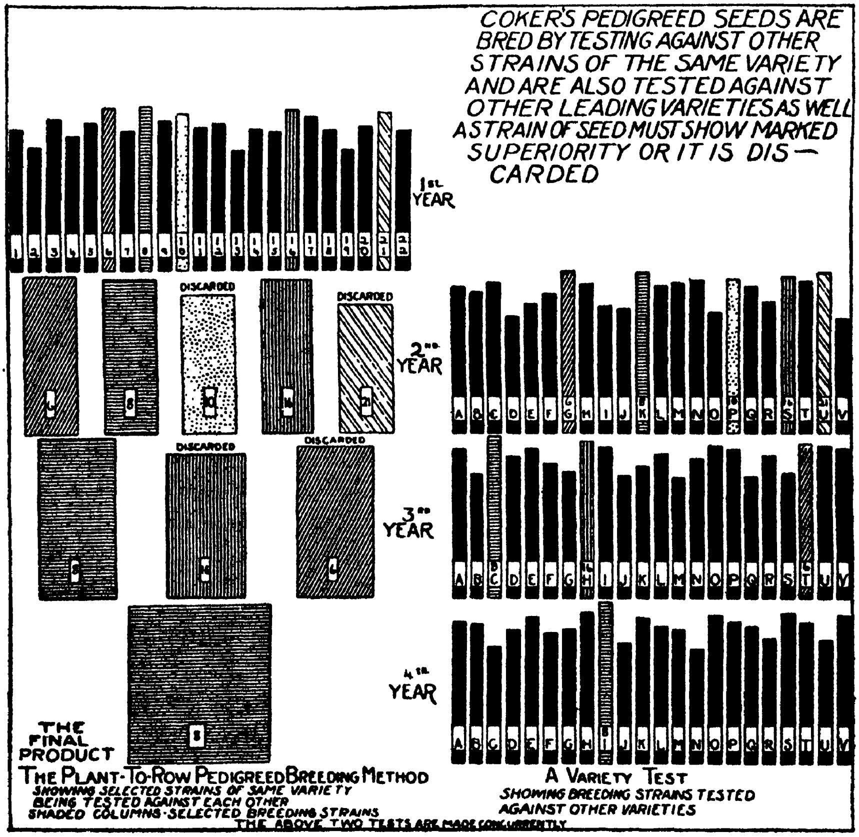
Speaking generally nitrogen and phosphates applied together had given the best results in crop yields and vigour of the plants. The yield under weevil conditions was also influenced by the effect of these two manures in hastening the maturity of the crop. Potash in these soils appeared to have a depressing effect on the crop.

At the Georgia State College of Agriculture at Athens the main plant-breeding work was with a variety called College No. 1, now largely cultivated throughout the State and produced on this station by crossing Columbia with one of the Big Boll Cleveland strains. All the varieties grown in the variety tests here were more hirsute than those seen elsewhere, showing that this character is partly influenced by soil environment. Varieties which had been noted elsewhere as being hairy-leaved showed up this character very markedly at this station. Seed of two varieties was obtained here. One of these was College No. 1 which, though not in itself generally particularly hirsute, contained the strain of Columbia, which is quite a promising variety in this respect. There was quite an interesting manurial experiment being conducted here, testing the effect of lime in conjunction with other manures. Half of each plot had been limed for the last fifteen years. Where no lime had been applied and where no lime was contained in the manures applied, the cotton had not only made very poor growth, but the stand was exceedingly poor. In some plots there was hardly any stand at all. Wherever lime had been applied the stand was good, and the crop had a healthy appearance. I was told that the effect of this liming had only shown itself during the last three seasons. Unlike the experiments at Griffen, potash here had shown good effects. Some of the statistical results of experiments done at the College were of interest. Taking the acre yield and the price of cotton it was found that those varieties which paid best were all from 1 to $1\frac{1}{16}$ inch staple. The only exception to this was a variety known as Foster, an early maturing cotton which gives a staple of from $1\frac{1}{8}$ to $1\frac{3}{16}$ inches.

In South Carolina private enterprise has done much to improve cotton by seed selection and plant breeding. Hartsville in this State has become quite a centre for staple cotton as a result of the work done by the Coker Pedigreed Seed Company. It is this firm which produced among others the Webber cotton, which is reported to have done so well in Mesopotamia. I spent a very interesting week at Hartsville, and am much indebted to Mr. D. R. Coker, the President of the Company, for the trouble which he and his assistants took, not only in showing me what there was to see, but in making my stay there comfortable. I arrived there at the end of September, and though my visit was timed to see the cotton in the field at its best, it unfortunately coincided with the time when the plant-breeding work was at its busiest. Mr. Wilds, the plant breeder, did all that he could, however, to show me everything connected with his work, but I should have liked to have spent more time with him.

This was a real experimental cotton-breeding station, and I was very impressed with the high standard of work which was being done, and with the results obtained. I cannot do better than give the following extract from the Pedigreed Seed Company's own list for 1921, which shows the methods adopted by them in their work:

OUR PLANT-BREEDING METHOD GRAPHICALLY ILLUSTRATED.


COKER'S PEDIGREED SEEDS ARE BRED BY TESTING AGAINST OTHER STRAINS OF THE SAME VARIETY AND ARE ALSO TESTED AGAINST OTHER LEADING VARIETIES AS WELL. A STRAIN OF SEED MUST SHOW MARKED SUPERIORITY OR IT IS DIS-CARDED
1st YEAR
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
2nd YEAR
DISCARDED
DISCARDED
4 8 10 14 21
A B C D E F G H I J K L M N O P Q R S T U V
3rd YEAR
DISCARDED
DISCARDED
8 14 4
4th YEAR
THE FINAL PRODUCT
8
THE PLANT-TO-ROW PEDIGREED BREEDING METHOD
SHOWING SELECTED STRAINS OF SAME VARIETY BEING TESTED AGAINST EACH OTHER
SHADED COLUMNS - SELECTED BREEDING STRAINS
A VARIETY TEST
SHOWING BREEDING STRAINS TESTED AGAINST OTHER VARIETIES
THE ABOVE TWO TESTS ARE MADE CONCURRENTLY

"The chart graphically illustrates the method of pedigreed breeding that has been used by this Company for nineteen years. The first year illustrates the plant-to-row tests, including only twenty-two plants because of space. The heights of the different columns illustrate the comparative value of the different rows or progenies as determined by yield and value. Five superior progenies or families are chosen for further trial. A few of the superior plants in each of these rows are chosen and picked separately for the plant-to-row tests the next year. All inferior plants are then removed and the remaining seed of each row is picked under the row or family number for further tests.

"The second year these five selected progenies or families are grown in increase blocks and also tried out in a general variety test. At the end of the second year No. 10 and No. 21 are discarded. (No further illustration is made of the plants selected the first year from the five good rows, as these plants are grown the second year in plant-to-row tests, and begin a new series.)

"The remaining families, Nos. 6, 8, and 16, of which 8 seems to be the superior one, are tested again in like manner the third year, at the end of which 6 and 16 are also discarded as inferior. No. 8, which is retained, has been demonstrated to be the superior strain of all of those first selected.

"The fourth year No. 8 is again tried out in the variety tests, and a large increase plot is grown to furnish seed to be used in growing a general seed crop.

"This process is a continuous one, and in the third and fourth years the families or strains as here illustrated will come in competition with later selections from the plant-to-row tests made the second year. It thus frequently happens that the pedigreed strain of a certain year may be discarded for a better strain the next year. The longer this continuous selection is pursued, the better and more uniform the pedigreed strain becomes. In all this breeding work accurate records are kept of every individual strain, and we are able to trace the ancestry or pedigree of any strain back to the original plant first selected."

Mr. D. R. Coker very kindly promised to send me small quantities of seed of several of the plant-to-row strains which appeared to me likely to suit the requirements of Nyasaland. I pointed out to him that I would prefer seed of some of these rather than the seed of strains which had been fully tested out in America, because our conditions were so different that it was more than probable that quite other strains than those put out might prove much better croppers under our conditions. I laid special emphasis on the hairiness of the leaf. Most of the Webber 49 strains were promising in this respect, and a certain strain of Cleveland was exceptionally good. This 1 understood would probably be discarded this year as it did not pass the local tests for yield.

Besides " straight selection " a certain amount of work had been done by cross-pollination, but so far this had not reached a stage when any results were available. The " straight selection " work was quite as much as could be carried through efficiently without the much more laborious work connected with crosses. Even with " straight selection " there appeared to me no doubt that some of the strains had originally been improved by natural cross-pollination.

Besides the Pedigreed Seed Company, there was also in Hartsville the Humphrey Coker Seed Company. I did not see any of the work at this station, but subsequently saw some of the crops raised from seed produced here which impressed me very favourably—notably " Coker's Carolina Foster," a particularly early long staple cotton, which had been bred for Carolina conditions from the Foster variety grown in Mississippi.

Very little plant-breeding work was being done at the State experimental station at Florence, as, I understand, the policy of the State is to leave this to private enterprise. As far as cotton was concerned, most of the work was in connection with experiments for boll-weevil control. There were four entomologists of the U.S.A. Department working here on boll-weevil problems. Very careful work was being done on the effect of removing the early formed squares as a measure of protection against boll-weevil. These results may prove useful in connection with similar work against red boll-worm. There were variety tests which were of interest to me, and I must in particular thank Mr. R. E. Currin, the Superintendent of the station, for the help and time which he personally gave me. It was with him that I was able to meet Mr. Watson, a seedsman in Florence, who was at one time connected with Dr. Orton of the U.S.A. Department of Agriculture, who has done such useful work on cotton wilt. Mr. Watson was continuing the work of breeding wilt-resistant cotton on a commercial basis, and I was able to see some of his selections which were yielding up to a bale per acre on badly wilt-infested land.

The last place that I visited before returning to Washington was the North Carolina State College of Agriculture and Experimental Station at Raleigh. I was very much impressed with what I saw of this college, and the manner in which the cotton work was organized. Besides the ordinary teaching staff, which in some colleges have not only to deal with cotton, but with several other crops as well, there was a cotton research officer attached to the college, whose only teaching work was that connected with the advanced work of post-graduate students. Dr. Winters was the officer concerned, and he has been some thirteen years in this appointment.

When he first took it up, he felt that, to make his research work of value to the State, he should at the same time organize the extension work outside, and much of the success of the cotton community work in this State is due to his efforts in this direction. Most of the plant-breeding work is in connection with the main local variety, Mexican Big Boll, and the strains produced on the experimental station are now largely grown throughout the State. I suggest that the Corporation might consider the advisability of sending some of their post-graduate students to this college. It has the great advantage that it deals with Upland cotton, and the conditions of climate and cultivation which suit this crop. Since a large portion of the future Empire cotton crop must be of this type of cotton, it seems only reasonable to take advantage of such training as exists in the management of this crop. One additional advantage which Raleigh has is that excellent training can be gained in grading cotton, as the central grading establishment of the North Carolina Cotton Co-operative Marketing Association is in Raleigh.

On my return to Washington I was able to meet many of the staff of the U.S.A. Department of Agriculture, and to thank Mr. Cook and Mr. Doyle of the Cotton Division for the assistance which they had given me in outlining my tour.

COTTON WEAVERS' DESIRE FOR MORE COTTON

BY

CEPHAS SPEAK

Secretary, Bolton and District Weavers' and Winders' Association.

THE cotton weavers of Lancashire and the adjacent counties are very much concerned about the supplies of cotton, not only as to quantities, but also as to qualities, because it is of such importance to their everyday life. The experience of the last few years has shown them, in spite of their lack of knowledge in the science of economics, that a shortage of cotton at any period has a serious effect upon the volume of trade, not only during the time of the shortage, but for a considerable time afterward, due to the increase in prices for cotton goods which a shortage of cotton generally causes, and the consequent dislocation of trade which occurs during the readjustment of prices. This affects the weavers and other workers seriously, because their wages are entirely dependent upon output, and bad trade necessitates their being put on short time, either by working reduced hours or by running only a portion of their machinery.

In normal times there are about 800,000 looms running in the trade, and the numbers of the work-people actually employed are approximately as follows:

Weavers	250,000
Winders, warpers, and beamers..	45,000
Overlookers (tacklers or loom tuners)	9,000
Twisters and drawers	7,000
Warp dressers	2,500
Warehousemen, cloth-lookers, sewers, knotters, etc.	7,000
Mechanics, engineers, joiners, firemen, etc.	1,000
Total	321,500

As a fairly large proportion of this number possess families, the probable number of people dependent upon them is approximately twice as many, so that it can safely be said that close upon a million people have to rely directly upon the wages earned in cotton weaving for their livelihood.

On account of the bad trade existing at the present moment, the number of persons working is probably reduced by about one-sixth.

The importance of the cotton-weaving section of the industry will be realized when it is remembered that in the year before the war 7,000,000,000 yards of cloth were exported from this country. Over 4,000,000 miles of cloth, much of it of fine quality, sent to all parts of the world, is the result of the work of many weavers, and those who help them in the processes preparatory to the weaving itself. This is in addition to the amount of cloth turned out from the looms for the home markets.

These figures show how necessary it is for Lancashire to be supplied with large quantities of cotton. The weaver is concerned about this matter for another very important reason. Whereas we have been supplying the world with a very large quantity of its plain qualities of cloth, we now find that other countries are producing more and more of these goods, and we are being compelled to go on to the finer cloths, and also cloths which are embellished in some way. This makes it essential for us to have yarns of a somewhat better quality than before, and a greater supply will provide this country with a better choice of cotton from which its yarns can be produced for the weaver to use. Naturally this would enable Lancashire to offer a wider choice of fancy ornamented goods to the peoples of other countries, and would lead to the revival of trade for which we are all so anxiously waiting.

This alteration in the character of our trade is being taken in a more philosophical spirit than alterations used to be taken in the earlier days of the cotton trade in this country. The change over from the hand loom to the power-driven loom was attended by much violence. The old weavers were afraid that the more rapid production of cloth would throw large numbers of them out of work, because fewer weavers would be required to turn off the same length of cloth. The weavers of the present generation are, however, not afraid as the past generations of weavers were, and they are fully aware of the necessity of making alterations to meet the various changes brought about by economic and other circumstances. They are very confident about their ability to meet changed conditions, if they are only given a fair chance, and Lancashire grit will bring them through successfully without any special favours being required. The mere fact that hand looms are now almost non-existent, and that their absence causes no comment, is perhaps sufficient to show that past events do not now trouble them.

There is also a great change in the character of the work of the weaver from the days of the hand loom. Then the weaver used to be very frequently his own employer, and had to travel to the markets to purchase his yarns and sell his cloth. This was the system by which the great cotton trade of Lancashire was built up, and the skill of those old veterans has to a large extent been inherited by the present generation of weavers; even though much of the work is done mechanically, there is still a large amount of skill required in the manipulation of the yarns. The young people of to-day learn the art of weaving at a very early age. It is a common custom for members of a family to take home bunches of yarn, and the youngsters are taught to become expert in the art of tying together broken threads. In this way they learn one of the first principles of weaving, even before they have seen a loom. Before the introduction of the forty-eight-hour week, and when there were two breaks in the working day, many of the young people used to take the breakfast of one or more members of the family to the mill, and the opportunity was taken to teach them many of the other principles in the art of weaving. There is a fascination about a weaving shed to the novice. The roar of the hundreds of shuttles which are being driven to and fro across the looms frightens many of them at first, but afterward the novelty of seeing the shuttle travelling through the yarn arouses their curiosity, and they generally want to know the reason why. Their training is speeded up because of this curiosity, and because of the latent skill which they have inherited from a long line of ancestor weavers. And Lancashire is proud to boast that its cotton weavers are still the best in the world.

The old hand-loom weaver was in many cases a combination of the whole of the workers mentioned previously—*i.e.*, he wound his own yarns, prepared his own beams, and twisted or drew in, and gaited up his own warps.

In those days there was not the necessity to make goods which would attract a market, as is largely the case to-day. Consequently, the hand-loom weaver who worked for himself could choose what class of cloth he would make, and was generally assured of a quick sale when his cloth was finished.

He would carry his goods to the nearest market town, and would also carry back his supply of yarns for future use. Gradually the system of marketing the cloth led to the elimination of the weaver employer, and the weavers began to work to given orders, many of them being under the supervision of one cloth merchant. Then the system of renting looms to weavers began, and was followed by the introduction of the employer who bought his looms and engaged weavers to work upon them for wages.

So long as the hand-loom weaver was working in his own cellar and without supervision, he would have his own time for doing his work. In fine weather he would often be out all day, sometimes tending his little plot of land, or his poultry or pigs, or whatever his fancy led him to have. If he felt inclined he would assist a neighbouring farmer during harvesting time, and he would frequently attend the rabbit-coursing, cock-fighting, and rat-hunting events which might be arranged.

He would then get through his weaving at night, often working very late, using candles or rush-lights for illumination. On occasions very good wages were earned by many of the weavers, and in some districts they were regarded as the aristocrats of labour; a large number of them used to wear silk hats and frock-coats.

The weaving was mainly the work of men, whilst the spinning was done by women, whose wages were not so good as those of the weavers. The introduction of power-driven machinery has completely altered this, and the whole of the cotton spinning in factories was, until recently, done by men, and to-day the whole of the mule spun yarns are made by men; the introduction of ring-spinning has brought about the employment of women, and practically the whole of the yarns spun on ring frames are made by women. On the other hand, weaving is becoming more and more a woman's occupation. At the present time approximately two-thirds of the weavers are women, and this proportion is gradually increasing, the tendency of the times being for men to seek other occupations.

The changed conditions of the work, and the enormous trade built up, has brought about many changes in the home-life and the manner of our living. There is not nearly the same interest in cock-fighting, rabbit-coursing, rat-hunting, and other sports of a similar character, and very few people in Lancashire take any part in them. The great manufacturing towns which have sprung up have brought with them amusements which are more common where large populations live, such as first-class football and cricket clubs, tennis and golf clubs, racecourses, besides theatres, music halls, and dancing-rooms, and many Lancashire towns possess most, if not all, these places. It is therefore apparent that the success of most of them depends upon the success of the cotton trade, and as they employ large numbers of people, it will be apparent that they are very much interested in the trade. But it is not to be thought that amusement is the only concern of the weavers when they have finished their daily toil. Thousands of them spend their spare time in attending evening classes at the Technical and Commercial Schools, in taking music and singing lessons, and lessons in elocution, whilst amateur theatricals and operatics are becoming increasingly popular. The weaver of to-day is a fairly well-learned person, able and anxious to take an intelligent part in the affairs of the world. The weavers are also very proud of their county and country. If they can be assured of a sufficient supply of good cotton, they will certainly maintain the position of Lancashire as the greatest cloth-manufacturing place in the world.

THE WORK OF THE IMPERIAL BUREAU OF ENTOMOLOGY

BY

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Assistant Director.

The Imperial Bureau of Entomology in its present form came into existence in April, 1913, the body from which it derives its origin, which was then known as the Entomological Research Committee for Tropical Africa, having been founded in 1909, with the late Earl of Cromer as its first Chairman. Though its expansion was to some extent hindered by the war, its work has been steadily increasing since its inception. It is managed by an honorary committee appointed by the Secretary of State for the Colonies, of which the Earl Buxton, G.C.M.G., is the present Chairman. Dr. G. A. K. Marshall, C.M.G., F.R.S., who was originally Scientific Secretary to the Entomological Research Committee, has been Director of the Bureau throughout its existence, and to him is due great credit for the considerable success it has attained.

Its funds are derived from the whole Empire, practically every part of which contributes in proportion to its means. As a result of the Imperial Entomological Conference held in London in 1920 a considerable increase of funds was granted to it, the Conference being unanimous as to the importance of the Bureau being placed on a permanent basis.

Before, however, going into the details of the work of the Bureau, I should like to say a few words on the general subject of applied entomology, with particular emphasis upon the great importance to the British Empire of some central clearing-house for insects and the problems connected with them, such as the Bureau provides. The basic work of such a Bureau must obviously be the collection and dissemination of all information likely to be of value to entomologists throughout the Empire. Original research—except to a limited extent in the case of the systematic study of insects—cannot be part of its primary duties. But, for the reason that knowledge concerning insects and other organisms that are potential crop pests should be obtained in advance of their reaching that status, it is not possible in research work to draw any clear distinction between economic and non-economic problems. Many an isolated fact, apparently of no economic importance, has subsequently proved to be a vital link in a chain of facts that have a far-reaching practical value. Instances might be multiplied from all over the world, where much might have been done to control insect pests with a minimum of delay if only more had been known beforehand as to their life-history and distribution. If, for instance, we had known fifteen or twenty years ago what we know now about the pink boll-worm of cotton (*Platyedra gossypiella*), which is probably indigenous only in India, and is an imported pest in Egypt and elsewhere, what vast sums of money could have been saved, and how much better the prospects of controlling this most serious menace to the cotton crop of the world would have been.

To realize the importance of these questions, we have only to consider how it is that insects come to be pests of our crops. It is not difficult to show that this is entirely due to the action of man himself. In order to make room for his own crops man destroys, wholesale, large areas of virgin forest which is populated by a great variety of animals and plants living in a state of equilibrium. In its place he often substitutes a single crop, such as cotton, with the inevitable result that he forthwith provides a vast new food-supply for any insect that lives on Malvaceous plants and can adapt itself to cotton, and at the same time he exterminates or drives away many of its competitors and natural enemies. Two lessons may be drawn from this—one that large unbroken areas of a single crop, where no rotation is practised, inevitably offer special risks of severe outbreaks of pests, and secondly that, given the knowledge with which research will ultimately provide us, the potentialities of and the remedies for a pest will be foreseen, and an outbreak can be dealt with without delay when it may arise.

It seems to me that this desirable result can only be arrived at by a proper marshalling of our forces and by organizing a satisfactory liaison between them. We may be said to have four lines of defence. The first of these is the individual planter himself who carries out the recommendations of the second line—*i.e.*, the local entomologist, whose position may be likened to that of the general medical practitioner. Research and teaching institutions, such as the Imperial College of Tropical Agriculture in Trinidad, constitute the third line, and not only may be said to represent the specialist in medicine to whom members of the second line go for advice, but they are also engaged in helping to create the members of that line. Lastly, we have a central organization such as the Imperial Bureau, which, to change our metaphor from a medical to a military one, may be said to represent the Intelligence Section of the Imperial General Staff. The function of this, the fourth line of defence, is not only to help both the second and third lines with information and advice from the extensive sources available to it, but to keep them informed as to the progress of the battle throughout the world.

To turn now to some details of the work of the Bureau. This is divided into two main sections: (1) The identification of, and reporting on the insect pests and the problems connected with them that are sent in from all parts of the world; (2) the publications.

The identification work is carried on at the head office of the Bureau at the Natural History Museum in South Kensington, where the great National Collection of insects is available for comparison. In order to give some idea of the extent to which this work has grown, the following figures for the year ending March 31, 1923, may be of interest. The number of insects received from all parts of the world was 56,000, or over a thousand a week, and the lists of named insects sent out involved 6,268 specific identifications.

The Bureau endeavours to maintain a collection of insects of economic interest for distribution to its correspondents abroad, but Directors of Agriculture and entomologists throughout the Empire must bear in mind that they cannot expect to receive from the Bureau specimens of insect pests from other countries unless they send to it a good supply of their own pests, since it is only by this means that such a collection of insects for distribution can be built up.

In this connection it must be remembered that the usefulness of the Bureau to any colony or association of planters is necessarily limited by the attitude of the body concerned. In the case of those Administrations that do not maintain the services of an entomologist, the use they can make of the Bureau is necessarily severely limited. It must not be thought, however, that the help that the Bureau is willing to render is given only to official entomologists. It is much to be hoped in years to come that still more individuals or companies who are planting on a large scale will employ their own entomologists or will combine to share the services of one, and will thus be able to utilize the resources of the Bureau to a greater extent than is possible for them at present.

The Bureau not only deals with noxious insects, but with beneficial ones, and a comparatively new branch of its work, which may have important developments in the near future, is the exportation of parasites to various parts of the Empire. The work is carried on at the cost of the Bureau and by a member of its staff, Mr. A. M.

Altson, at the Rothamsted Experiment Station. The chief parasites dealt with so far have been two Tachinid flies, parasitic on the common earwig, and Hymenopterous parasites of the pear-slug, all of which have been sent to New Zealand. It is hoped to send to Canada during the coming year some parasites of the wheat-stem sawfly, as a species closely allied to it occurs in England, though it is not a serious pest. This work, however, has certain inevitable limitations due to climatic conditions, and is therefore likely to be carried on chiefly for the benefit of those countries that have a temperate climate. None the less it has recently been found possible to establish in Muscid flies in England some Hymenopterous parasites of tsetse-flies from Nyasaland with a view to sending them out to Nigeria.

The Publication Office of the Bureau is at 41, Queen's Gate, a building owned and occupied by the Entomological Society of London, It is only a few minutes' walk from the Natural History Museum. and great advantage to all entomologists is derived from the presence under a single roof of the fine library of the Society, which is mainly systematic, and that of the Bureau, which is chiefly devoted to the economic aspect of entomology. The library of the Bureau, although only a little over ten years old, already comprises some 3,500 bound volumes, and a vast number of reports and separates which are all catalogued and card-indexed. These are all available for loan, though bound volumes are not usually sent abroad.

The chief work of the staff of the Publication Office is the production of the *Review of Applied Entomology*. This journal endeavours to give summaries of the whole of the world's literature on the subject, and is published in two series, "A" dealing with agricultural pests, and "B" with medical and veterinary ones. It has grown steadily since it first appeared in 1913, and the demand for it has also increased very considerably. The average number of separate abstracts published, which was about 1,500 annually for the first five years, rose for the next five years to about 2,000, while for 1922 and 1923 it was about 2,450. Recent volumes of both series combined, complete with their indices, have consisted of about 1,100 pages annually. In producing this journal great efforts are made to keep it up to date so far as it is possible to do so, and practically every original paper received by the Bureau is abstracted and published in the *Review* within six to eight weeks of its receipt. In view of the necessary delays involved in abstracting, editing, printing, and proof-reading, it is hardly possible to improve upon this. Very great importance is also attached to the indices, which it is essential should be very full in a journal of this character. The annual indices are published in June and July in the year following that of the volume to which they refer. It is also hoped to publish shortly a complete index to all the Arthropods in the first ten volumes of Series " B " of the *Review,* and to do the same for Series " A " at the completion of the thirteenth volume, a separate subject index to the first three volumes of that series having already appeared.

The other principal publication of the Bureau is the *Bulletin of Entomological Research,* which contains original articles on insects connected with both medical and agricultural problems. It is published in four parts a year, and is now in its fourteenth volume.

These publications are supplied free to all Governments contributing to the funds of the Bureau in proportion to their contributions, and are also sold to the public at a nominal price which in no way represents the cost of production. Indeed, in the case of the *Review of Applied Entomology,* it is very doubtful whether it could be produced at all on a commercial basis even if sold at a greatly enhanced price. Its preparation necessarily involves the employment of a considerable staff, and the careful examination of a vast number of periodicals or series of reports, this number having risen of late years to well over a thousand. These are, of course, received from all parts of the world, and it must be remembered that much valuable information published in such languages as Russian or Japanese would be lost to the English-speaking world but for the existence of the *Review.*

INSECT PESTS OF COTTON

BY

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AND

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The cotton plant, wherever it is grown, suffers from insect pests to an extent really greater than most staple crops. One reason is that it is one of the *Malvaceæ,* a family of plants which is widely spread both wild and in cultivation. Insects which have adapted themselves to any species of *Gossypium,* of *Hibiscus,* of *Abelmoschus,* seem to be able to adapt themselves readily to cotton, and this means that wherever cotton is brought into cultivation in new areas insect pests soon thrive upon it.

A second reason why insect pests are important is that we grow cotton for the sake of the fibre, which is formed round the seed in the boll: the boll is a very attractive breeding material for insects, with its content of soft, puffy, developing seeds, and the result is that the fibre, which is our main concern, suffers damage due to insects seeking to live on the seed.

To the cotton grower the insect pest is a real danger, and the whole industry which ultimately depends upon the produce of the cotton plant has been very deeply affected by the attacks of pests such as the boll-weevil and boll-worm.

In the following pages are given a general account of the more important pests; perhaps those who deal in cotton, who use it in manufacture, will be interested in knowing of the pests which beset the grower. It is a far cry from the cotton grown in the fields of Queensland to the mill in Lancashire, but the influence of the insect in the fields is felt even in the mill, and will probably be felt even more in the future.

THE STATUS OF THE INSECT PESTS OF THE GROWING COTTON PLANT.

The cotton plant is an important source of food to the teeming insect fauna of the tropics. More species of insects appear to attack cotton than any other cultivated plant. Over five hundred species of insects—and with the insects are included a number of other deleterious invertebrates, amongst which mites are the most important—have been mentioned at one time or another as feeding on cotton. It is attacked in all stages and in all its structures. The seedlings, as soon as they appear above ground, are devoured by grasshoppers, lepidopterous larvæ or cutworms, and herbivorous feeding beetles, to such an extent that acres have frequently to be resown. The older but still succulent plants suffer especially from attack to the developing leaf buds, to the flower buds, or squares, and to the tender growing points of the stem, by the sap-sucking bugs, a fly maggot, and the boring lepidopterous larvæ. When the leaves are fully developed they are fed on by more bugs, more lepidopterous larvæ, and a host of other insects such as mites, aphides, leaf-feeding beetle larvæ, leaf-boring fly grubs, thrips, and, in fact, by representatives of almost every insect order. Those flower buds that have escaped attack give rise to short-lived blooms which do not escape entirely, for they are attacked by flower beetles.

Meanwhile, the roots have not escaped attention; for the usual soil fauna of eelworms, millipedes, wireworms, and other beetle larvæ find in them abundant nourishment. But it is when the seeds begin to develop and the young green bolls form that the attacks become of real importance, for it is at this stage that most of the major insect pests of cotton become prevalent in the fields.

Up to the formation of the seeds all the boll-worms have to feed on the squares or on the inside of some green and tender shoot; but it is inside the bolls, actually feeding on the developing seed, and thus effectually decreasing the production of lint, that these pests become most numerous and important. It is, of course, at this stage also that the notorious Mexican boll-weevil becomes really serious and increases rapidly in numbers.

Whereas the boll-worms damage the cotton only as larvæ or caterpillars, the adults being harmless moths, the boll-weevil is important in both stages. The grubs feeding inside the boll prevent the formation of the seeds or reduce their vitality so that they do not produce good lint, while the adult beetles fly from plant to plant, feeding from the outside of the bolls and squares, and by means of a chiselling and boring movement reach the soft internal structures which are their main articles of diet.

Other important pests at this stage are the cotton stainers. These are true bugs, and like all bugs feed by sucking up the sap of the plants through their long proboscis, which is driven into the various plant tissues. The cotton stainers themselves feed on the bolls. Having pierced the surrounding bracts, the proboscis is forced into the developing seeds, from which the bugs extract the nutritious sap. The importance of these stainers is not, however, due so much to this direct damage, but more to the fact that they are the carriers of disease. In some way, as yet not fully understood, these insects transfer bacterial and fungoid disease from boll to boll as they feed. The infection, known as internal boll disease, causes a staining and rotting of the lint, depreciating its value and its quantity very considerably. This disease has been very prevalent in the West Indies, and recent investigation shows its presence in Tanganyika Territory and Nyasaland.

In this case the disease has been definitely found to be transferred by the stainers and a few other bugs. It is, however, more than probable that many other fungoid diseases are carried by insects that feed on the cotton, and also that other diseases gain entrance into the tissues through the wounds caused by insect attack.

In another indirect way these stainers and a number of other insects are important. Thus, when the cotton is ginned the presence of large numbers of these insects produces a staining of the lint which can by no means be ignored.

From this brief survey it is obvious that the cotton plant is never free from the attentions of the insect fauna; the plant tissues are being devoured by one insect or another from the time of sowing until the picking is complete. It is a wonder that any crop can be gathered at all, and as Mason has pointed out, the boll-worms alone damage 70 per cent. of the crop in Nyasaland, and even under these conditions the growers procure a reasonable return so that the potential producing capacity of such a country is enormous.

The cotton plant, *Gossypium*, belongs to the natural order *Malvaceæ*, which also contains many common wild and cultivated plants that occur throughout the tropics; and it is only to be expected that in many cases we should find the cotton-feeding insects, in some cases willingly, and in others only in emergency, turning their attentions to the other closely related malvaceous plants and, *vice versa*, when cotton is introduced into a country, the indigenous malvaceous-feeding insect fauna migrating to the cotton-fields where food may be found in plenty. The cotton plant seems particularly attractive, probably because of the sweet exudation of the glandular structures that are present on many of the plant organs. The various Hibiscus, Bhindi, Okra, Hemp, etc., and Hollyhock are examples of common malvaceous plants which may not only account for the origin of certain cotton pests, but also serve as the source of food which supports the pests throughout the winter months when cotton is unobtainable. For the above reason it is easy to understand the appearance of cotton pests wherever cotton be grown, and in any large cotton area we may be sure that sooner or later at least one of the cotton feeders will find the conditions suitable enough to enable it to attain the rôle of a major pest.

Thus in the American cotton belt the pest of primary importance is, of course, the boll-weevil. The story of this insect is well known, but a few of the outstanding facts may be mentioned here. The weevil is confined at present to Mexico, Central America, parts of Cuba, and the United States, but the exercise of great care will be required to prevent its accidental introduction into the cotton areas of the British Empire. The weevil is probably a native of Central America, where it fed on the native cotton trees, and it was little known until 1892, when it crossed the Rio Grande at Gainesville, and thus gained a footing in the United States. Since that date there has been an annual spreading of the pest in a northerly direction, until to-day it is found in every cotton-growing state. This rapid dispersion is due to a natural migratory habit of the adult weevils in the autumn, when they take protracted flights in search of fresh feeding grounds. In 1922 the weevil infested 13,000 fresh square miles of the cotton belt. The weevil is endangering the cotton-growing industry of America, and, *pari passu*, the Lancashire cotton industry, for the financial loss due to the lessened production caused by direct attack is enormous. Some figures recently published in America are illuminating. In the years 1909-13 the average annual percentage of potential production prevented by the weevil was estimated at 5·1 per cent. In the years 1919-21, which are the last years for which these figures are available, the estimates are 13·7, 20·5, and 33·6 per cent. respectively. In 1921 the actual value at farm prices of the picked product prevented by boll-weevil attack was estimated at 610,341,000 dollars; 90 per cent. of this represents loss in lint. It has been stated that the boll-weevil destroys more cotton than is used by all the cotton mills of this country.

The boll-weevil has fortunately a restricted distribution, but this cannot be said of the pink boll-worm (*Platyedra gossypiella*). This moth, for the worm is the caterpillar stage of a minute and insignificant moth, is found throughout the world, and is a serious menace to all cotton-growing countries. This insect's native home is probably in South-East Asia, though some authorities consider it as coming from the Sudan district. It was first recorded in India in 1843; it arrived in Egypt in either 1906 or 1907, probably by way of Palestine, and in Egypt it soon became dominant, and was recognized as an important pest in 1912. It had reached German East Africa in 1904, and since then the moth has spread to the Sudan, to East, West, and Central Africa, to Australia, across the Atlantic to both South and North America, and thence to the West Indies, arriving there as late as 1920. It is present in Hawaii, Fiji, and Mesopotamia. No reports of its presence have come from South Africa. The American outbreak is at present not serious, and the American entomologists expect to be able to exterminate it.

The life-history of the pink boll-worm is unfortunate. It is modified in such a way as to give the insect the very best chance of becoming dispersed to all the tropical regions of the world, where its food plants are grown.

Each female moth lays from 250 to 500 eggs on the cotton plant; in Egypt, for example, the first eggs are laid on cotton about June. After four to five days a very active little caterpillar emerges and immediately bores its way inside a boll or bud to feed on the inside of a seed or upon the ovules. The larva feeds for about twelve days, during which period it destroys two or three seeds, and then either within the boll or in the ground the larva turns into the pupal stage, which lasts on the average about ten days. The moth then emerges, and within a few days commences its egg-laying. In this way the complete life-cycle occupies only five weeks on the average, and much less in many cases. This is the usual procedure during the summer months when food is abundant, but from September onwards an important change takes place. The larvæ, when they approach maturity, spin a cocoon within a seed, and in doing so are careful to spin up a second seed to cover up the entrance hole, forming what is known as the double seed. But instead of pupating these larvæ remain in a resting condition for a long period, tiding over the winter months when food is scarce, and complete their development the following spring. These resting-stage larvæ have been known to exist in this condition for as long as thirty months, and, of course, during this period the seed may be transported from one side of the world to another, the moths emerging in due course to infest fresh cotton areas. With reasonable care there is little likelihood of the boll-weevil spreading to the Old World, but with the pink boll-worm it is different, and unless all cotton seed that is transported away from any infected area is thoroughly disinfected by heat treatment, which ensures the death of all insect life, we may expect to hear of the gradual depreciation of the cotton production of those few remaining cotton fields that are free of the pink boll-worm.

The estimates of the damage caused by this pest in different parts of the world are by no means complete, but are of extraordinary interest. In Egypt, where the pest is most important, the percentage of seeds damaged was estimated to be in 1912 3·9 per cent., in 1915 this had risen to 10·7 per cent., and in 1916 to 15·1 per cent. To-day the damage is estimated at about 20 per cent. of the crop. In India an examination of a large number of bolls in 1919 showed that during July the percentage of attacked bolls rose from 40 to 80 per cent., and in September stood as high as 91·6 per cent. One estimate from the West Indies gives the loss in 1921 at 5 to 25 per cent. of the crop, and in Brazil it was estimated at 30 to 66 per cent. in 1917.

The pink boll-worm is a typical boll-worm in its damage, but it is only one of many such pests. Other important moths are those belonging to the genus *Earias;* the most important of these, *E. insulana*, commonly known as the spiny boll-worm, is another very widely distributed insect. It is found throughout the African continent, it is common throughout India and Burma, and it has gained a footing in Queensland and also in Brazil. Another species, *E. fabia*, is only really serious in India, and especially so along the eastern coast. These two species have at times been especially noticeable, as in the years 1905, 1909, 1910, and 1918, and of these the 1905 outbreak was outstanding. Such a sudden outbreak emphasizes the importance of the natural control of insect pests by their natural enemies and the effects of abnormal weather conditions. In this year an unusually cold winter killed off the principal insect parasites and predators, but did not harm the Earias themselves, so that in the summer the moths were free to multiply unchecked. To prevent a recurrence of this catastrophe, the most important parasite, a minute braconid known as *Rhogas Lefroyi*, Ashm., is bred at the agricultural stations in India and immediately despatched to any district where the Earias seem to be dominant or where the parasite is noticeably absent.

This is the effect of a cold winter in India: in America, under boll-weevil conditions, we find just the opposite. Here the weevil hibernates through the cold months, sheltering in fallen leaves, moss, and rank undergrowth without feeding, and the number of beetles that emerge the following spring to infest the new cotton crop varies according to the mean winter temperature. During a mild winter many beetles survive, but if there are long spells of frost only the hardiest or best protected beetles pull through and the cotton growers enjoy an unusually full crop.

There are two other boll-worms of major importance, the Sudan or red boll-worm (*Diparopsis castanea*, Hamps.), and the American boll-worm or corn earworm (*Chloridea obsoleta*, F.). The former is confined to the African continent, but is one of the most important pests to the British cotton grower. It is serious in the Sudan, Nigeria, Uganda, Nyasaland, and South Africa, but is noticeable for its absence from Egypt. From Nyasaland it is reported as a pest of great importance, and from South Africa as accounting for the destruction of 60 per cent. of the bolls. The American boll-worm, on the other hand, is another of the very widely distributed pests; it may be described as universally distributed, and occurs occasionally in this country; it feeds on many plants, and is a first-class pest of both maize and cotton. It is second in importance to the boll-weevil in the United States, and its damage there to cotton alone was figured at 8,500,000 dollars in 1917, and to all crops at 30,000,000 dollars. In Egypt, on the other hand, it has only once (1905) been recorded as doing any appreciable harm. In India its status is very variable; in 1917 it was reported as occurring "on cotton, but rather as a curiosity than as a pest," while in 1920 it was doing more damage at Coimbatore than both the Earias species and the pink boll-worm together. In the Sudan it is more a pest of other crops than cotton, and in the West Indies it is not important. In Australia, however, serious damage is reported. The American boll-worm attacks cotton also in Hawaii, Nyasaland, South Russia, and Annam.

As has been described, the bolls are not only destroyed by the internal feeding of the boll-worms, but also by the external attacks of bugs, amongst which the cotton stainers (*Dysdercus* spp.) and the dusky bugs (*Oxycarenus* spp.) are prominent. The genus *Dysdercus* contains over seventy species, but of these, only twenty-two have been recorded as cotton feeders, though the remaining species should be watched as potential pests. The economic species are widely distributed; in fact, the only cotton areas of importance that are free are Egypt, South Russia, and Mesopotamia; however, the two species that occur in America (*D. suturellus* and *D. albidiventris*) do not occur throughout the cotton belt, being found only in the south-east and south-west regions. *Oxycarenus* is another large genus, and the seven cotton-feeding species have a wide Old World distribution, being especially prominent in Africa; they are also found in Mesopotamia, India, Burma, and Australia.

The cotton leaves support a very large and mixed insect fauna which is very variable as to its economic importance. Some of the most prominent of the leaf feeders, and certainly those most noticed by the cultivators, are the larvæ of a number of moths, and amongst these the cotton worm (*Alabama argillacea*, Hübn.) is remarkable for its varied status. It is found practically throughout South and North America and the West Indies, and is probably indigenous to Brazil. In the American cotton belt the severe outbreaks have occurred, either by chance or otherwise, in regular twenty-one-year cycles; such outbreaks were recorded in the years 1783, 1804, 1825, 1846, 1868, 1872,* 1890, and 1911. Before the coming of the boll-weevil this insect was considered one of the worst pests of cotton that claimed the attention of American entomologists, for in bad years it practically denuded the bushes of their leaves, and had generally the appearance of a pest of the deepest dye. The caterpillars were so abundant that they were regularly fed to the turkeys, they were used as food for pigs, and even cats and dogs were observed to feed upon them. But the boll-weevil has somewhat modified the status of this moth, and now the year 1932 will be welcomed by both entomologist and cotton grower, by the one to test a doubtful hypothesis, and by the other as heralding a cotton crop free from any serious boll-weevil attack. The cotton worm has become an indirect, but very real, enemy of the boll-weevil.

In the cotton fields, as the season advances, the number of fallen bolls and squares that lie beneath the plants increases, and it is in these fallen bolls that the boll-weevil breeds profusely. Under normal conditions these bolls are well protected from the blazing sun by the mosaic of leaves of the cotton plant above, but if these are removed by man or caterpillar—and the latter is by far the most efficient—then these bolls on the ground and also the lower bolls on the plants, which were also shaded, become heated to such a temperature as is fatal to any boll-weevil grub within. Moreover, without the leaves the crop will mature earlier, and the picking will be complete before the boll-weevil attack has attained its maximum. For in obtaining a good yield under weevil conditions it is chiefly a matter of obtaining an early crop by means of early sowing, by using early maturing varieties of cotton, by thorough cultivation, and by any other method, including the ravages of the cotton worm.

All the pests that have been dealt with are of such a size that the cotton cultivator may readily be aware of their presence in his fields, and he will understand that they are capable of causing grievous harm to the plants; but many of the very important pests are exceedingly small and inconspicuous, and as a rule the cultivator does not see in the swarm of " flies " that are constantly to be seen around the cotton plants, or in the less active and still less obtrusive organisms that remain on the stems and leaves, the real cause of his unhealthy and unproductive plants.

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* This is the only year in which an outbreak occurred not in accordance with the twenty-one-year sequence.

Of these smaller pests the cotton thrips (three spp. of *Heliothrips*) is one of the most important, especially to the grower in the Anglo-Egyptian Sudan, being also found in North and South America, the West Indies, South Europe, India, and Java. The adult insect is a little over 1 mm. in length, and possesses two pairs of beautifully feathered wings; they usually rest in small depressions of the leaf, and move about by walking and by jumping, but if disturbed they do fly for small distances, usually circling around the plant. The adults feed by sucking the sap from the leaves, preferably on the upper surface, and beginning on the lower leaves of the cotton plant work upwards, giving the plant a characteristic white or silvery appearance; the leaves eventually wither and fall, and the younger plants are frequently killed. The eggs are laid in an incision made on the under-surface of the leaf; the larvæ that hatch are similar to the adults, but do not possess wings, and they damage the plants in a similar way. After a few days the larvæ descend and become quiescent in some crack in the earth, and twelve days later the adult thrips emerges. These insects feed on a great variety of wild plants, and when the cotton is not growing they migrate to these plants and are able to subsist on them until the next cotton season. Thus it is obvious that clean cultivation is a very important check; hoeing exposes the quiescent stages to the fatal heat of the sun, and as moisture hinders their development, heavier watering may be advised. In this latter respect it is interesting to note that infestations are always more severe in those parts of the field that are exposed to any drying wind.

The cotton aphis (*Aphis gossypii*) is another of these small insects of importance. Widely distributed over the world and feeding on a large variety of plants, this aphis occurs in practically all the cotton fields of the world. Its feeding causes a curling and dwarfing of the leaf and malformation of the plant to a very serious extent. It is preyed on by many other insects, which check it to a far greater degree than any artificial control as yet devised. Both the black and white scale (*Saissetia nigra* and *Hemichionaspis minor*) are of first-class importance, and finally there are two mites which should be mentioned. The cotton woolly mite (*Eriophyes gossypii*), found in the West Indies, India, and the Gold Coast, forms blisters on all the plant structures, except the root, destroying the axillary buds and preventing the development of the all-important lateral shoots. Seeds in an infected area should be disinfected either by a solution of mercury perchloride or by fumigation with carbon bisulphide, so that the spread of the pest may be prevented. The most hopeful method of checking this pest is in the development of a mite-resisting strain of cotton plants, a method that is being investigated in the West Indies. The red spider (*Tetranychus* spp.), of world-wide distribution, is usually found on the underside of the leaf, where it spins a silken web under which it feeds protected from weather and insect enemies. The attacked leaves turn red, wither, and fall; in the south-east regions of the American cotton belt the annual damage is estimated at about 2,000,000 dollars, and in Russia it is suspected of carrying disease.

In this description of the major insect pests of the cotton plant, emphasis has been laid on the importance and efficiency of natural checks and indirect methods of control, which are as a rule more effective in the long run when dealing with large infestations than any carefully conceived mechanical or chemical process. As regards these latter, there are usually insurmountable difficulties in the form of expensive apparatus or supply of material; thus in the case of the boll-weevil it has been found that the best method of poisoning the beetles is by a thorough application of a fine powder of pure calcium arsenate, but not only have expensive and, as a rule, inefficient machines to be used for the application, but the annual world's output of calcium arsenate is not sufficient to treat the entire American cotton belt during one season. Also, unless care is taken the cultivator spends more on the poison and its application than he gets from his increased output.

In order that these pests may be controlled it is absolutely essential to observe in every detail their life-history, to find out their natural enemies and their food plants; it is then often possible to find some weak spot in their annual cycle, where some small change may be effected and the cycle disrupted.

Many of the cotton pests, while feeding whenever possible on the cotton plant, have alternative food plants, of which the Malvaceæ are the most important, to which the insects migrate when the cotton crop is over, and in these cases the obvious and ideal method of dealing with the pest is the destruction of all the available food throughout the winter. Not only must the cotton plants be ploughed up and burned as soon as the picking is over, but all the alternative food plants must similarly be dealt with. This principle has been widely recognized and has resulted in the formation of laws decreeing the destruction of the cotton crop before a certain date. The beneficial result of such a campaign has been well shown in certain of the West Indian islands, where the cotton stainers have been reduced practically to the point of extinction.

The major pests of to-day may be overcome by science or, more probably, by natural means, but wherever cotton is grown we may safely say that some insect will rise from that vast horde of cotton feeders to the status of important pest. The more man cultivates the world the more is the balance of nature upset. Fresh land is reclaimed, native plants destroyed, cotton is introduced, the insect life finds a new and wholesome food, certain species thrive and become dominant, and the entomologist is faced with a new problem. But there is no need for it to be a baffling problem so long as he studies not only the present major pests of cotton, but also the more numerous minor and potential pests.

A REPORT ON A VARIETAL TEST WITH COTTON ON THE GOVERNMENT EXPERIMENTAL STATION, RUSTAM, BAGHDAD, IN 1922.*

BY

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A. INTRODUCTORY.

In all crop-introduction work the first problem that confronts the agronomist is to determine if the climatic and soil conditions of the locality concerned are suited to the cultivation of a given crop. When it has been once established that the given climatic environments and soil conditions do suit the growing of the crop in question, the next important problem is to discover the variety or varieties that will yield the best results under the average conditions of the locality. The Varietal Tests which are the subject of this Report are a means to this end.

The Varietal Test of 1922 was one of a series of experiments that was laid down for cotton research.

The statistics collected for the other experiments in the series are in course of analysis, and the results will be published in due course.

B. VARIETAL TESTS OF 1918 TO 1921.

Cotton experimental work in 'Iraq began with the sowing season of the year 1918. The site of the first cotton experimental station was selected at Karradah, a suburb of Baghdad. The more important conclusions drawn from the Varietal Test of 1918 were as follows:

(1) The climatic and soil conditions obtaining at the Baghdad Cotton Farm in 1918 were well suited to the cultivation of American

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* This article is extracted from a Bulletin published separately by the Corporation as Memoir No. 8 of the Department of Agriculture, Iraq, and is given here on account of its general interest as a good piece of work upon sound lines, of the kind that will have to be carried out in every cotton-growing country, actual or potential, of the Empire. For full details reference must be made to the Bulletin itself.—Ed.

Upland, "Improved" Upland, and Egyptian types of cotton represented by the varieties under experiment.

(2) It is probable that the water requirements of the cotton crop in Mesopotamia will be appreciably greater than is the case in Egypt.

(3) Of the varieties under trial, *Webber* 49 showed a remarkable combination of good characters.

(4) Mesopotamia can grow cotton of the Egyptian type, whose quality in regard to length, strength, and fineness equals, and may even surpass, that of the same average type grown in Egypt.

(5) American varieties can be grown, whose quality is far superior to that of the average cotton crop of America.

In 1919, in addition to the main varietal test at the Baghdad Cotton Farm, there were carried out supplementary varietal tests at six testing stations scattered over the country. While the varietal test at Baghdad was a comparative trial for twelve varieties, the varietal tests at the outlying testing stations were restricted to six of the varieties which held out the greatest promise. On account of the difficulties peculiar to the circumstances then prevailing in the country, the experiments at the testing stations could not be given the uniform treatment designed for them. For instance, the date of sowing at the several stations varied from the end of the second week in April to as late as the second week in May. Again, the crop at Amarah suffered from a severe attack of grasshoppers, while the experiment at Nasiriyah had to be abandoned owing to the appearance of excess of salt when the plots were irrigated. In these circumstances, it was not considered justifiable to draw conclusions of general applicability. The varietal test at the Cotton Farm, Baghdad, was in the same year undertaken under more normal conditions. The Cotton Expert in his Administration Report for 1919 enumerates the more prominent features of this experiment as follows:

(*a*) The results confirm the contention that the 1918 varietal test, *per se*, was practically valueless in so far as the solution of the primary problem was concerned—that is, to discover which of those varieties of cotton under trial was best suited to local conditions. With the more uniform treatment which it was possible to exercise in 1919, the order of priority, as shown by relative values, has been materially altered.

(*b*) The three varieties which gave the best financial returns are *Ashmouni* (Egyptian), *Punjab* 285 *F* (Indo-American), and *Webber* 49 (American). The latter variety continues to show an excellent combination of characters, but it has been surpassed (in relative value) by the other two named varieties.

(*c*) The high average yields obtained in 1918 were maintained, and in most cases surpassed.

(*d*) The average number of irrigations, as anticipated, has varied from 12 to 13⅔, exclusive of the initial irrigation given before sowing to determine the water level on the individual ridges.

(*e*) The 1919 test confirms all of the conclusions which it was possible to draw from the 1918 experiment.

(*f*) The test, in so far as it is concerned with the relative value of each variety, is still indeterminate. The results need confirmation at Baghdad and at other testing stations before it will be possible to speak with finality.

It was accordingly decided to repeat the varietal test in 1920 before embarking on extensive propaganda amongst cultivators. In 1920 the Baghdad varietal test was repeated at Baqubah, Hillah, Kut, and Sherghat. Early in the season these experiments on the four outlying farms showed every promise of giving results of real value. Their subsequent fate may best be described in the words of the Cotton Expert, who, in his Administration Report for 1920, wrote as follows:

"The history of these farms for the remainder of the season, though perhaps of no scientific value, is worthy of record as indicative of the conditions under which work is being conducted. The tale is one of disaster. The crop at Sherghat was completely eaten up by locusts; that at Kut suffered from severe drought owing to the irrigation plant breaking down, and the crop was abandoned; the Baqubah Farm was looted by the rebels during the disturbances, and the cotton crop pilfered; at the Hillah Farm, the attacking rebels found good cover in the cotton crop, with the result that the farm was under shell fire from our guns for some months."

Fortunately, throughout the Arab Rebellion of 1920, it was possible to continue unmolested the experiments at the Cotton Farm, Baghdad. The chief features of the 1920 varietal test on this station are summarized below:

(1) The yield of seed-cotton of almost all the varieties, as recorded in 1920, was appreciably lower than that in 1919. The decline in yield was attributed to the poverty of the soil, due to continuous cropping and no manuring.

(2) In a few cases, plots that were treated in as identical a manner as was possible under the conditions of the place, showed very

considerable differences of yield. Such differences greatly vitiated the value of the data collected.

(3) The relatively high yield obtained with *Webber* 49 in the previous years was maintained in 1920. This fact, in conjunction with the excellence of its staple, indicated the suitability of *Webber* 49 for cultivation in Mesopotamia; and, consequently, it was definitely decided to confine seed distribution amongst cultivators to this variety only, until such time as another variety might prove superior to it. Owing to the fact that the Mesopotamian produce of this variety possessed certain intrinsic merits as distinguished from its parent stock in America, it was decided to rename this cotton with the commercial name of "*Mesowhite.*"

The lease of the Cotton Farm, Baghdad, having expired at the end of 1920, it was decided to restrict all further cotton research to the recently acquired lands attached to the Agricultural Research Station at Rustam. This estate is situated on the right bank of the River Dialah, about nine miles east of Baghdad. The varietal test of 1921 was a comparative trial with seventeen varieties of cotton, eight of which were pure bred strains selected locally by the Cotton Expert from imported stock. This experiment was remarkable for the extremely low yields recorded. All of the varieties under experiment were severely affected by the adverse conditions under which the crop was cultivated. The chief factors which restricted the yield of all varieties in 1921 are believed to be the following:

(1) The estate on which the experiment was conducted had been acquired only a short time previous to the cotton sowings. There was insufficient time to give the land the desired preliminary cultivation. The tilth at the time of sowing was far from being satisfactory. Tho date of sowing was unavoidably delayed. The germination was so poor that extensive resowings had to be made late in the season when the hot summer weather had set in. These resown plants remained stunted in growth throughout the season, and suffered severely from the hot dry winds of July and August.

(2) The soil was extremely deficient in organic matter, as a result of constant cropping with cereals by the previous tenant.

(3) Constant difficulties experienced with the recently erected pumping plant resulted in the water-supply being uncertain and insufficient during the most critical month of July, when the water demands of the cotton crop reach their maximum. The paucity of organic matter in the soil affected its capacity for retaining water. This feature necessitated more frequent irrigation even than that normally given to the cotton crop.

(4) The available labour on this new estate was altogether inexperienced in the technique of field experiments. Despite constant supervision, much difficulty was experienced in carrying out the programme of cultivation.

(5) The summer of 1921 was one of exceptionally high temperatures, and fairly continuous hot and strong winds.

(6) It has been found necessary in 'Iraq to grow on the channel banks, surrounding the plots of cotton, a wind-break of castor plants to protect the cotton crop from the strong winds of July and August. In 1921 the wind-break of castor was not given a fair opportunity to establish itself. The cotton crop was, therefore, exposed throughout to the full force of the winds.

It may be noted, however, that none of the above factors would, if operating alone, be sufficient to effect such a marked decrease in the yield of all varieties of cotton as recorded in 1921. But with all these adverse factors being operative simultaneously, the effect on the crop was most pronounced.

The obvious lesson to be drawn from the 1921 experiment is the fact that conditions of climate and soil in 'Iraq are well suited to cotton cultivation, only provided adequate treatment is given to the crop. Such adequate treatment comprises nothing more than the selection of land which contains the essential manurial ingredients, suitable and timely preliminary cultivation, timely sowing, regular irrigation, and an efficient wind-break.

In spite of the comparative failure of all varieties in the 1921 experimental work, it is of special interest to note that under the adverse conditions to which the crop in general was subjected, the Egyptian varieties (*G. barbadense*) included in the experiment fared considerably worse than the American varieties (*G. hirsutum*). Adverse conditions especially in regard to water-supply are by no means exceptional in the irrigated cotton areas of 'Iraq, and it is only under the most favourable conditions that Egyptian cotton can be expected to be grown at a profit.

[The details of the 1922 work follow here, and will be found *in extenso* in the Bulletin.—Ed.]

E. CONCLUSIONS.

The following may be enumerated as the chief conclusions that can be drawn from the 1922 varietal test:

1. That the water requirements of the cotton crop at the Rustam Experimental Station, Baghdad, are appreciably higher than those recorded for the same crops at the Cotton Farm, Karradah, Baghdad.

At Rustam the average number of waterings demanded by all varieties in 1922 was fourteen; at Karradah the average for all varieties in 1919 was 12 waterings, and in 1920, 12·6 waterings.

2. That regular and timely irrigation, according to programme, is a matter of vital importance to the successful cultivation of cotton in 'Iraq. In 1921, owing to difficulties experienced with the pumping plant, there were inordinate delays in irrigating the experimental plots, especially during the most critical period in the life of the cotton plant—namely, July and August. As many as 16 waterings were given to the experimental plots in that year at irregular intervals; but the net result was an average of 100 lbs. of seed-cotton per acre, as compared with an average of 2,110 lbs. of seed-cotton per acre in 1922, when the crop was given only 14 waterings according to programme.

3. That provided the land possesses the desired manurial constituents, and the cotton crop is properly treated in its early stages, then with irrigation at intervals of nine to ten days during July and August a heavy yield can be obtained.

4. That under the conditions that prevailed at Rustam in 1922, cotton plants of the "*hirsutum*" (American) type had two distinct periods of reproduction. The first period extended from the middle of July to the end of August; and the second period, during which between 60 and 70 per cent. of the total crop was harvested, extended from the beginning of October to the middle of December. During the month of September the harvest from all "*hirsutum*" varieties was negligible. Local cotton (*G. herbaceum* type) continued to yield fairly regularly throughout the season.

5. That the varieties *Cawnpore* 9, *Rustam* 20, *Rustam* 47, *Sudan*, and *Rustam* 48, in the order named, gave yields of seed-cotton which were distinctly heavier than the average plot yields of the remaining varieties under experiment.

The differences in the yield of these five varieties are so small in relation to the "probable error" of these differences that there is insufficient justification for asserting that the cropping qualities of these varieties are definitely established in the order named.

6. That on the basis of average yield of raw cotton multiplied by the valuation for that particular variety, *Rustam* 20 takes precedence at Rs. 41·5 per one-twentieth acre plot in the order of cash values. It is closely followed by *Cawnpore* 9 at Rs. 40·4 per plot. Both these varieties are relatively short-stapled, and relatively late in maturing. In their present state, both varieties are comprised of mixed types as the result of natural cross-fertiliza-

tion. These and other considerations preclude them from being distributed to cotton cultivators at the present stage.

7. That the variety of cotton named *Webber* 49–3 (imported in 1920 from Messrs. the Pedigreed Seed Company, Hartsville, South Carolina) possesses a combination of good characters, and it appears to be a slight improvement on the original *Webber* 49. Its relatively early maturing habit, its fairly high yield of seed-cotton coupled with a satisfactory ginning out-turn, and its comparatively high crop value—these considerations make it a desirable variety to propagate. About 2,000 acres of this variety are under cultivation this year, with the view to its cultivation by cotton growers in 'Iraq to the exclusion of all other varieties in 1924.

8. That a careful analysis of the yield records indicates that the heaviest yields of seed-cotton are generally associated with tall plants which develop three or four monopodia (vegetative branches) and a profusion of long, slender, and tough sympodia (flowering branches) having moderately short internodes. This plant habit seems to be well suited to the climatic conditions of 'Iraq. It may be noted parenthetically that the *Webber* (*Mesowhite*) type of cotton plant does not possess these latter features to the desired degree. It is hoped, however, to evolve by artificial cross-fertilization the ideal form of cotton plant by combining in one individual the desirable lint characters of the *Webber* type with the plant habit of the Indo-American varieties. Efforts have already been directed to this end with promising results.

BAGHDAD,
December 13, 1923.

"WORN OUT" COTTON VARIETIES*

BY

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IT is generally believed by cotton merchants and growers that no variety of cotton can maintain a standard of quality for many years and that inevitably it must deteriorate. The now extinct "Yannovitch" and the deteriorating "Sakellaridis" are given as obvious examples. The fatal description of being "worn out" affords a satisfying explanation. This is due to confusion between the age of variety and age of a crop. Each crop being the product of one generation cannot be said to be "worn out" either more or less than any other crop.

Each generation is liable to express its own individuality with more or less divergence from or resemblance to its ancestry. A slight divergence from the ancestral type may appear at first only in a few individuals, but if such individuals are also characterized by increased fertility or seed production their proportion in subsequent generations will gradually increase until they become the dominant type of the crop, so that the original variety can no longer be said to exist.

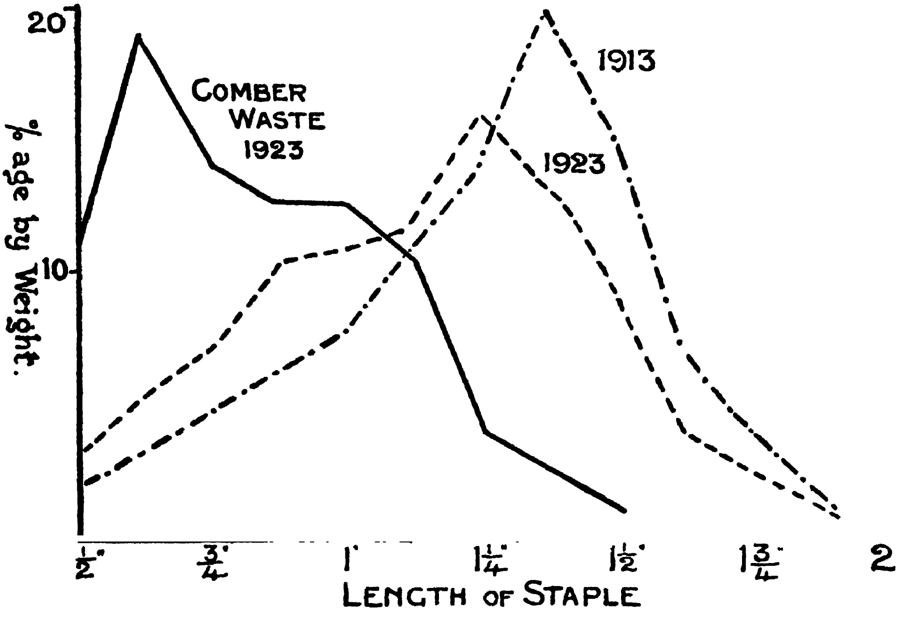
It should be remembered that the spinning quality of lint has no significance in the life-history of the cultivated cotton plant. (Its probable function in the wild state is dealt with by the writer elsewhere.)[1] A decrease of ¼ inch in the length of staple or a slight increase in the thickness of the fibre, whilst having a profound effect on the spinning quality, cannot be said to inconvenience the plant in any way or to indicate senile decay. Thus a cotton variety may deteriorate considerably in a commercial sense without any loss of vitality. In fact, it may show increased vigour.

* This paper gives an interesting account of the "deterioration" (from a commercial point of view) of the well-known Egyptian variety, Sakellaridis, with actual figures obtained from two samples taken at different dates. Although it is scarcely likely that the particular samples investigated by the author are typical of the whole crop of those years, the paper calls attention to the desirability of making use of the technical organization which the cotton trade has developed since 1913, in order to bring together a sufficient number of commercial Sakel samples from various years whereby to obtain a series of typical samples upon which the existence of any progressive change in the physical properties could be statistically demonstrated.—ED.

The deterioration of the Egyptian crop has been the subject of much concern during recent years. It has been discussed very thoroughly by Dr. Balls[2] with regard to the decrease in yield. The present writer has had occasion to investigate it from the spinner's standpoint.

Commercial samples of Sakel of the 1913 and 1923 crops were obtained by courtesy of Messrs. Stead Brothers, of the Liverpool Cotton Exchange. These samples were examined by the Balls sorter[3] for distribution of staple length, and for diameter by the method of Calvert and Harland.[4] These two measurements were taken as being the most useful and convenient data for comparisons of spinning quality. A spinning test is more of the nature of a verdict than an explanation, and is of little assistance to the grower. The results obtained are compared with the results of similar measurements on comber waste of the 1923 crop produced in the spinning laboratory of the Technical College, Manchester.

DISTRIBUTION CURVES OF STAPLE LENGTH OF SAKELLARIDIS.



"MODIFIED DIAMETER" OF HAIRS.

Sample.	*Mean Diameter* (100).	*Probable Variation or P. E. of Mean.*
1913	13·44	± 0·18
1923	15·37	± 0·23
Waste	15·83	± 0·274

It will be seen that the most frequent staple length has decreased from 1⅜ inches in 1913 to 1¼ inches in 1923, and that there is a distinct bulge in the 1923 curve between 1⅛ inches and ¾ inch, so that a much larger area of this curve comes within the " waste " area. Thus from a comparison of distribution of staple length alone a very effective measurement of the deterioration is obtained. This method of comparison is more reliable for the grower than the more skilful method of the grader or broker. It gives a more tangible result, and one that can be accurately recorded for future reference.

Comparing the mean cell diameters of the three types of cotton we have still further evidence of the deterioration of the 1923 crop in the decrease in the fineness of the fibres.

The comber waste, in addition to the broken fibres of finer quality, appears to contain fibres of shorter staple and larger diameter, and the 1923 crop differs from the 1913 crop in the same respect. This mixing of fibres is also indicated by the increase in the probable variation of the mean diameter.

These results are of considerable biological significance. It is very natural to assume that the quality of the crop must be considerably influenced by the cultural conditions and that badly grown plants must needs produce inferior cotton. This leads to a further assumption that seed selection and precautions for maintaining the purity of a strain are of less importance than cultivation. If this is so, improvement in cultivation and nutrition of the plant will produce a finer cotton—*i.e.*, one with a smaller diameter, which is obviously untrue. And conversely, if it is maintained that defective nutrition will cause a decrease in staple length, how are we to account for the increased thickness? Further, the decrease in yield in the Egyptian crop began in 1904, or ten years before the deterioration of Sakel occurred.

Obviously some other factor must be included. The crop may have been contaminated with inferior varieties—*e.g.*, Ashmouni, from Upper Egypt—or the original variety was not uniform.[5] Both events are highly probable causes.

A pure strain is a biological possibility, its absolute permanence is a matter of prediction, and dependent upon subsequent realization. Its perpetuation unchanged depends upon continuous and accurate control and thorough elimination of incoming rogues.

Obviously the fewer the unit characters required to determine the strain the easier will be the work. Unfortunately it is not yet known for certain how many factors are concerned in the inheritance of such a simple character of staple length,[6] and still less is known about the inheritance of cell diameter and thickness of cell wall. Accurate information on these points is impossible until pure lines of very extensive history have been secured.[7] This work is also the basis of uniformity in the lint, which is perhaps the most important character of all from the spinner's standpoint. In the meantime ordinary hybridization work will continue to give disappointing results, not only because of confusion in tracing the inheritance, but also because the maintenance and preservation of well-known strains is of more importance to the consumer than the introduction of new ones.

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COTTON-GROWING STATISTICS—III.

COMPILED BY

JOHN A. TODD.

As promised in the April issue, two tables are here given embodying the details of the Indian crop: (1) by provinces, and (2) according to different varieties. The former of these goes back to 1911, so that it covers a pre-war period of four years; two earlier, but incomplete, records of area in 1874 and 1887 are also added for comparison. The information as to varieties first began to be published regularly by the Government in 1915.

In studying these tables along with the summary published in the previous issue, perhaps the most striking feature is the extraordinarily wide fluctuations of the average yield per acre, which, within the period shown, has been as low as 61 pounds, and as high as 99. On examining further the detailed tables here given, it will be seen that this same feature is characteristic not only of individual provinces, but also of particular varieties. While some provinces are, on the whole, always higher than others, all of them are subject to very wide fluctuations, the maximum being, as a rule, almost three times as much as the minimum. For comparison it may be noted that in America there is not the same range, even in recent years since the advent of the boll-weevil. In India the difference is mainly climatic, and simply goes to show the extreme range of climatic variations and the speculative character of the cotton crop as a result.

The same characteristic works out in another way—namely, the extreme range of the maximum and minimum yields in any one season in different provinces, the maximum being, as a rule, about four times the minimum, and often much more; in other words, in every season some provinces do exceedingly well, and some very badly. This, again, is natural in view of the enormously wide area which the crop covers.

The same tendency is brought out by the variety figures. While some varieties, on the whole, always yield more than others, all of them are subject to very heavy fluctuations, there being, as a rule, a range of about 100 per cent. between maximum and minimum.

It is of special interest to note that the arrangement of the different varieties in the Government forecasts makes it quite easy to divide the whole list into two main categories, those of short staple up to approximately ⅞ inch, and those which are, on the whole, of ⅞ inch and upwards. In Table IV. (*f*) the separate totals for these two main groups have been worked out, and two rather striking facts may be noted: (1) the extraordinary uniformity of the relative percentage of short staple and long staple—*e.g.*, the percentage of short staple (both for area and crop) only five times goes above 75 per cent. and only three times falls below 70 per cent.; (2) the remarkably uniform relation between the total yields per acre of short staple and long, the former being substantially higher in every case but one. That is a point which must always be kept in view in considering the possible development of long staple cotton in India. It is notable, however, that the yield of the long-stapled group as a whole fluctuates much less widely from year to year than the short staple.

NOTE.—ERRATUM. TABLE IV. (*b*) WEST INDIES.

By an unfortunate typographical error the yield for Barbados in 1923 in last issue was given as 108 bales instead of 1,080. This makes the grand total for the year (which, however, is still incomplete) 4,773 instead of 3,801.

TABLE IV. (*e*).—INDIAN COTTON CROP: AREA

	*Early Area Records.**		1911-12.			1912-13.		
	1874-75.	1887-88.	*Area (in Acres).*	*Crop (in Bales of 400 Lbs.).*	*Yield (in Lbs. per Acre).*	*Area (in Acres).*	*Crop (in Bales of 400 Lbs.).*	*Yield (in Lbs. per Acre).*
Madras	1,577	1,400	2,878	335	47	2,414	471	78
Mysore	37	43	101	17	67	154	19	49
Hyderabad	941	1,000	3,234	300	37	2,888	300	42
Bombay	4,230	5,616	5,121	599	47	6,064	1,324	87
Sind	—	—	346	124	143	296	123	180
Baroda	—	—	665	96	58	762	196	128
Central Prov. and Berar	2,862	2,512	4,648	913	79	4,493	910	81
Central India	—	290	1,400	228	65	1,314	206	62
Bengal	—	162	63	25	159	51	21	164
Bihar and Orissa ..	—	—	88	19	86	92	19	83
United Provinces ..	1,126	1,526	921	251	109	1,158	428	148
Rajputana	—	450	263	73	111	393	125	127
Ajmer Merwara ..	—	18	27	12	178	50	26	208
Punjab	711	645	1,582	241	61	1,575	373	94
North-West Frontier ..	—	—	56	12	86	56	13	93
Assam	38	1	36	11	122	35	10	114
Burma	17	8	186	32	69	233	46	79
Total	—	—	21,615	3,288	61	22,028	4,610	83

	1917-18.			1918-19.			1919-20.		
	Area.	*Crop.*	*Yield per Acre.*	*Area.*	*Crop.*	*Yield per Acre.*	*Area.*	*Crop.*	*Yield per Acre.*
Madras	2,592	450	69	3,133	581	74	2,339	408	70
Mysore	154	23	60	125	14	45	145	18	50
Hyderabad	3,451	450	52	2,406	643	107	3,095	749	97
Bombay†	7,697	1,403	73	5,547	641	46	5,857	1,505	103
Sind	267	53	79	317	114	144	319	84	105
Baroda	914	239	105	814	81	40	794	127	64
Central Prov. and Berar	4,582	591	52	4,135	807	78	4,600	1,289	112
Central India	1,454	116	32	1,236	214	69	1,591	219	55
Gwalior				(Previ	ously in	cluded	in Cen	tral Ind	ia)
Bengal	71	19	107	73	32	175	69	25	145
Bihar and Orissa ..	69	17	99	79	20	101	78	17	87
United Provinces ..	1,315	198	60	862	174	81	1,268	436	138
Rajputana	435	54	50	250	55	88	371	99	107
Ajmer Merwara ..	70	14	80	30	14	187	44	24	218
Punjab	1,800	307	68	1,550	493	127	2,269	682	120
North-West Frontier ..	38	5	53	39	7	72	51	11	86
Assam	32	13	162	32	12	150	32	14	175
Burma	247	48	78	369	70	76	430	89	83
Total	25,188	4,000	64	20,997	3,972	76	23,352	5,796	99

* From *Indian Cotton Statistics*

† Including Native States, Sind

CROP AND YIELD PER ACRE *BY PROVINCES.*

1913-14.			1914-15.			1915-16.			1916-17.		
Area (in Acres).	*Crop (in Bales of 400 Lbs.).*	*Yield (in Lbs. per Acre).*	*Area (in Acres).*	*Crop (in Bales of 400 Lbs.).*	*Yield (in Lbs. per Acre).*	*Area (in Acres).*	*Crop (in Bales of 400 Lbs.).*	*Yield (in Lbs. per Acre).*	*Area (in Acres).*	*Crop (in Bales of 400 Lbs.).*	*Yield (in Lbs. per Acre).*
2,725	308	45	2,115	245	46	2,061	245	48	2,168	347	64
93	11	47	109	14	51	92	14	61	126	16	51
3,653	400	44	3,605	400	44	2,964	450	61	3.200	500	62
6,574	1,439	87	6,953	1,544	89	4,439	934	84	6,330	1,475	93
341	135	158	336	116	148	161	48	119	240	78	130
749	175	94	843	229	109	566	117	83	707	171	97
4,754	961	81	4,708	1,097	93	4,061	1,106	109	4,402	691	63
1,426	273	77	1,519	293	77	999	216	86	1,419	311	88
87	24	115	90	34	151	88	30	136	73	20	110
73	17	93	70	16	91	67	16	96	68	16	94
1,586	484	122	1,551	486	123	834	262	126	1,185	309	104
470	132	112	421	166	157	244	62	102	334	128	153
57	15	105	54	15	111	23	2	35	47	35	300
2,053	612	119	1,857	486	105	902	195	86	1,163	335	115
59	14	95	60	14	93	26	4	62	28	6	86
33	12	146	34	12	142	32	10	125	32	11	137
290	54	75	270	42	62	187	27	58	223	40	72
25,023	5,066	81	24,595	5,209	85	17,746	3,738	84	21,745	4,489	83

1920-21.			1921-22.			1922-23.			1923-24.		
Area.	*Crop.*	*Yield per Acre.*	*Area.*	*Crop.*	*Yield per Acre.*	*Area.*	*Crop.*	*Yield per Acre.*	*Area.*	*Crop.*	*Yield per Acre.*
2,150	358	67	1,803	341	76	2,348	431	73	2,669	480	72
111	11	40	59	15	102	83	24	116	84	15	71
2,214	341	62	2,914	870	119	3,813	1,116	117	3,500	1,079	123
5,688	927	65	4,678	1,137	97	5,819	1,329	91	6,294	1,128	72
275	42	61	(Now included in Bombay)								
792	127	64	600	85	57	585	116	79	657	76	46
4,477	514	46	4,414	1,127	102	4,857	1.040	86	4,901	1,020	83
876	119	54	714	158	89	889	181	81	1,041	187	72
456	43	38	355	46	52	523	74	57	500	60	48
71	21	118	65	15	92	72	17	94	71	21	118
78	15	77	79	15	76	80	15	75	81	16	79
1,161	337	116	828	244	118	652	182	112	652	215	132
375	81	86	297	68	92	302	76	101	324	73	90
42	15	143	26	12	185	36	15	167	41	13	127
2,142	588	110	1,239	296	96	1,394	397	114	1,914	628	131
27	5	74	15	3	80	15	3	80	23	4	70
39	14	144	40	13	130	40	14	140	39	14	144
366	42	46	325	40	49	284	45	63	297	46	62
21,340	3,600	67	18,451	4,485	97	21,792	5,075	93	23,088	5,075	88

by A. F. B., Bombay, 1889.

since 1921, and Delhi.

000's omitted throughout in area and crop figures.

TABLE IV. (*f*).—INDIAN COTTON CROP: AREA,

Varieties.	1915-16.			1916-17.			1917-18.			1918-19.		
	Area.	*Crop.*	*Yield per Acre.*	*Area.*	*Crop.*	*Yield per Acre.*	*Area.*	*Crop.*	*Yield per Acre.*	*Area.*	*Crop.*	*Yield per Acre.*
								0	00's o	mitted	throu	ghout
I. MAINLY BELOW ⅞ INCH STAPLE.												
Oomra:												
Khandeish	1,222	340	111	1,510	342	90	1,441	192	53	1,395	148	42
Central India ..	999	216	86	1,419	311	88	1,454	116	32	1,236	214	69
Barsi and Nagar ..	3,168	483	61	3,449	539	62	3,643	474	52	2,471	647	105
Hyderabad Gaorani				(Inclu	ded i	n Bar	si and	Naga	r)			
Berar	2,869	830	116	3,118	691	63	3,214	428	53	2,882	498	69
Central Provinces	1,192	276	93	1,284			1,368	163	48	1,253	309	99
Oomra Total ..	9,450	2,145	91	10,780	1,881	70	11,120	1,373	49	9,237	1,816	79
Dhollera	1,180	150	51	2,061	585	114	3,413	680	80	1,775	118	27
Bengal Sind Total	2,262	591	105	3,103	930	120	4,066	669	66	3,146	880	112
United Provinces	834	262	126	1,185	309	104	1,315	198	60	862	174	81
Rajputana ..	268	64	96	415	185	178	573	88	61	294	71	96
Sind Punjab ..	1,089	247	91	1,431	419	117	2,105	365	69	1,906	614	129
Others	71	18	101	72	17	94	73	18	99	84	21	100
Total under ⅞ inch staple	12,892	2,886	89	15,944	3,396	85	18,599	2,722	59	14,158	2,814	79
Per cent. of total crop	*72·5*	*77·2*	—	*73·4*	*75·5*	—	*73·9*	*68·1*	—	*67·2*	*70·8*	—
II. MAINLY ⅞ INCH STAPLE AND ABOVE.												
American:												
Punjab										(Inc	luded	in
Sind												
Broach	1,044	230	88	1,226	304	99	1,346	314	93	1,363	169	50
Coompta Dharwar	1,031	231	90	1,385	260	75	1,781	356	80	1,551	252	65
Western & Northern	1,350	172	51	1,583	238	60	1,596	169	42	1,812	232	51
Coconada	251	35	56	275	48	70	261	29	44	272	51	75
Tinnevelly	568	84	59	647	134	83	577	99	69	1,385	344	99
Salem	281	32	46	334	47	56	649	217	134			
Cambodia												
Coomilla, Burma, etc.	329	68	83	351	75	85	379	94	99	497	116	93
Total ⅞ inch staple or over	4,854	852	70	5,801	1,106	76	6,589	1,278	78	6,880	1,164	70
Per cent. of total crop	*27·5*	*22·8*	—	*26·6*	*24·5*	—	*26·1*	*31·9*	—	*32·8*	*29·2*	—
Grand total ..	17,746	3,738	84	21,745	4,502	83	25,188	4,000	64	21,038	3,978	76

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* Includes non-Government areas in Hyderabad.

CROP, AND YIELD PER ACRE *BY VARIETIES.*

1919-20.			1920-21.			1921-22.			1922-23.			1923-24.		
Area.	*Crop.*	*Yield per Acre.*	*Area.*	*Crop.*	*Yield per Acre.*	*Area.*	*Crop.*	*Yield per Acre.*	*Area.*	*Crop.*	*Yield per Acre.*	*Area.*	*Crop.*	*Yield per Acre.*
in area and crop figures.														
1,472	445	121	1,310	168	51	1,203	312	104	1,410	332	94	1,394	284	81
1,591	219	55	1,332	162	49	1,069	204	76	1,412	255	72	1,541	247	64
1,736*	352	81	1,057*	162	61	1,549*	386	100	2,180	628	115	1,974	578	117
1,158	335	116	893	122	55	1,125	420	149	1,439	451	125	1,400	500	143
3,115	931	120	3,123	288	37	3,140	818	104	3,356	695	83	3,320	1,020	83
1,485	358	96	1,354	226	67	1,274	309	97	1,501	345	92	1,581		
10,557	2,640	100	9,069	1,128	50	9,360	2,449	105	11,298	2,706	96	11,210	2,629	94
2,205	510	93	2,408	453	75	1,845	455	99	2,014	489	97	1,965	288	59
4,453	1,366	123	4,164	1,093	105	2,280	622	109	2,428	695	114	2,790	850	122
1,268	436	138	1,161	337	116	828	244	118	652	182	11[illegible]	652	215	132
464	133	115	477	105	88	371	90	97	396	102	103	406	92	91
2,639	777	118	2,444	635	104	999	272	109	1,295	395	122	1,647	526	128
82	20	98	82	16	78	82	16	78	85	16	75	85	17	80
17,215	4,516	104	15,641	2,674	68	13,485	3,526	104	15,740	3,890	99	15,965	3,767	94
73·7	*77·9*	—	*73·2*	*74·2*	—	*73·2*	*78·7*	—	*72·2*	*76·7*	—	*69·1*	*74·2*	—
						401	79	79	382	117	123	599	234	156
Sind	Punjab)								7	4	229	5	3	240
1,283	308	96	1,273	199	63	949	168	71	1,130	281	99	1,176	203	69
1,318	296	90	1,301	216	66	926	212	92	1,130	189	67	1,501	221	59
1,766	274	62	1,431	147	41	1,125	142	50	1,657	167	40	1,974	169	34
28	3	43	240	42	70	212	42	79	279	55	79	254	50	79
										141		617	167	108
956	234	98	948	242	102	894	238	106	1,048	23	112	201	26	52
										130		360	151	168
787†	165	84	507	81	64	459	72	63	419	78	74	436	84	77
6,138	1,280	83	5,700	927	65	4,966	953	77	6,052	1,185	78	7,123	1,308	73
26·3	*22·1*	—	*26·8*	*25·8*	—	*26·8*	21·3	—	*27·8*	*23·3*	—	*30·9*	*25·8*	—
23,353	5,796	99	21,341	3,601	67	18,451	4,479	97	21,792	5,075	93	23,088	5,075	88

† Includes Coconadas in Madras.

MISCELLANEOUS NOTES

OFFICERS ON LEAVE.

When an officer of a colonial Department of Agriculture (or of the allied departments of Irrigation, Transport, etc.) comes " home " on leave, he usually brings with him much information that may be of considerable value to similar officers in other colonies, or to the officers of the Empire Cotton Growing Corporation, who have to collect, collate, and use all possible information relating to cotton. The Corporation would consequently much appreciate the courtesy if Directors of Agriculture and others would be so kind as to inform them, in advance if possible, of the names, probable addresses, and approximate dates of arrival in England of officers coming on leave. This would give the Corporation the opportunity of getting into touch with these officers themselves, and of giving the latter the opportunity of meeting with one another. A further courtesy would be conferred if the officers themselves, upon arrival, would report at, or inform, the offices of the Empire Cotton Growing Corporation, which are at the corner of Millbank and Wood Street (entrance by the first door in Wood Street) immediately opposite to the offices of the Crown Agents for the Colonies.

At the date of writing the following officers are on leave in England:

Antigua	Mr. F. G. Harcourt.
Ceylon	Mr. C. H. Gadd.
Gold Coast	Mr. W. C. Fishlock.
,,	Mr. T. Hunter.
,,	Mr. H. J. Horwood.
,,	Mr. J. Steele.
Kenya	Mr. A. Holm.
Malay States	Mr. D. H. Grist.
Nigeria	Mr. O. T. Faulkner.
,,	Mr. H. G. Burr.
,,	Mr. H. B. Waters.
Palestine	Mr. J. Joanoglou.
,,	Mr. H. Raczhowsky.
Sierra Leone	Mr. M. T. Dawe.
Tanganyika	Mr. A. H. Kirby.
,,	Mr. D. Prain.
Uganda	Mr. S. Simpson.
,,	Mr. T. D. Maitland.
Egypt	Mr. A. C. Burns.

Mr. B. C. Burt, Secretary of the Indian Central Cotton Committee, Bombay, is also on leave in this country.

The following officers of the Corporation are at present on leave, or are shortly arriving, in England:

St. Vincent, West Indies	Mr. L. H. Burd.
Nyasaland	Mr. H. C. Sampson.

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THE TRANSPORT OF COTTON IN AFRICA

BY

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It has been said, and there is much truth in the generalization, that cotton growing in Africa is very largely a question of transport facilities. It is quite certain that there is no advantage in growing cotton or anything else in commercial quantities unless it is possible to transport it at reasonable cost to the nearest railway or port. The intention of this paper is not to dogmatize on the solution of the problem of African transportation; it is rather an attempt to set forth existing conditions and difficulties and to indicate some of the lines on which investigation might be fruitful. At present these conditions and difficulties are such that the only possible general solution of the question is to be found in the building of many railways. This, it is evident, is not a practical possibility, because the necessary capital is not available for the many hundreds of miles of railway that will, in the future, be both necessary and productive, and even if capital were available, there is not yet a prospect of sufficient freight to pay interest on it. Railways can only be constructed gradually. For the present we must be content with those that are most urgently required, and must try to adapt and improve other means of transport so as to fit them in both with present conditions, and with a scheme of eventual railway development.

There is great variety in the types of transport used in the continent of Africa. In South Africa, where, although there are occasional devastating epidemics, cattle thrive well, the best-known and most generally used form of cross-country transport has been the ox wagon. This vehicle, with its team of sixteen oxen, can take a load of between 7,000 and 8,000* pounds along even the worst of the South African roads. Within limitations the natives of South Africa thoroughly understand oxen, and most Dutchmen and some Englishmen can handle the unwieldy vehicle with a skill that has to be seen to be appreciated. Provided that there is grazing for the oxen and no danger of " East Coast fever " or tsetse fly, the ox wagon is, even at present, the most efficient and cheapest form of transport, and is universally employed all over the High Veld. It is, however, very slow; there are limits to the number of oxen that can be grazed along a road, and, east of the Drakensberg, there is always some risk of an outbreak of East Coast fever, which might completely disorganize a transport system.

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* Loads of up to 10,000 pounds have been carried in South African ox wagons. It should be remembered that very heavy loads involve double teams where the road is very bad or the gradient very steep; over such places the wagons are hauled one at a time.

In East Africa, until a certain amount of motor transport was introduced, the use of natives as porters was universal; natives are still used to a considerable but diminishing extent, but many of them now push carts rather than carry loads on their heads. There are some great advantages in porters who are independent of roads, for they can go wherever there are foot-tracks, and can negotiate natural difficulties insuperable by any other form of transport. Head porterage was, and still is, on the whole very cheap, being sometimes as low as 1s. 6d. per ton mile, and is easy to obtain, for many natives rather like this type of work and prefer it to agricultural labour. On the other hand, porters cannot carry more than 60 to 70 pounds, the distance they can cover in a day is limited, and although the requirements of more productive labour have not yet clashed seriously with transport requirements, there is no doubt that they will do so in the comparatively near future. It is, in fact, a most wasteful and unprogressive form of transport which must sooner or later be discarded.

In the Sudan and various other parts of Africa, the camel is the principal means of transport and, provided that the country is level and dry, he is a most efficient and useful beast. Out of his proper environment, however, he is perhaps the most difficult of created animals, and liable to suffer from unexpected diseases and disabilities. The load he can carry is not a great one in any case, and depends on the type of camel, the nature of the country, and the distance of the journey. For short journeys, a load of 500 to 600 pounds is the maximum, and therefore a camel is practically useless for the transport of cotton after it has been ginned, compressed, and baled, for two bales make too heavy a load, and one is almost impossible to rope on to a camel.

In Northern Nigeria camels, donkeys, ponies, and oxen are all used for transport. They all have advantages for short journeys, but their value, broadly speaking, may be said to vary inversely with the distance over which the load is to be carried.

In Southern Nigeria, cross-country transport is done by porters.

The foregoing notes do not pretend to do more than indicate the various types of transport used in those areas where cotton is grown. To a certain extent, all of them are being gradually replaced by motor transport, which, however, is expensive, because of the cost of petrol, and because the surface of the roads and the strength of the bridges are not able to carry large vehicles with large and therefore economic loads. At present it is necessary to employ a high proportion of European drivers, or, if native drivers are employed, to keep a staff of European mechanics to instruct the native drivers to deal with breakdowns on the road, and to carry out all important overhauls. In either case overhead charges must be heavy. An increasing number of natives is being trained to drive, but very few are efficient mechanics or capable of carrying out more than the simplest roadside repairs. Generally speaking, their reputation as drivers is that they are very rough with their engines, and the maintenance of a native-driven motor car is said to be very expensive. They are, however, employed with a considerable degree of success in Uganda.

RAILWAYS.

In Africa, in spite of cheap native labour, railway construction is relatively very expensive in comparison to its earnings, because of the long distances to be covered and the sparse population. The cost of materials, such as rails and rolling stock, is high, because of heavy charges for freight. In the past some railways have been built through unsurveyed regions, a necessity which naturally added to their expense in various ways, and, although conditions are improving in this respect, the proportion of the continent that has been accurately surveyed is still very small. If railways are costly to build, they are even more expensive to maintain. When first made there is usually little for them to carry, and therefore the disproportion between cost of maintenance and earnings is very marked, although there are a few instances of African railways carrying large quantities and paying their way almost as soon as they have been completed; the new extension of the Uganda Railway through the cotton-producing area of the Eastern Province of Uganda will, it is hoped, add to the number of these instances.

Heavy initial expenditure, high cost of maintenance, and small earnings (for some years at least) have hitherto made it usual for the Government or administration concerned to undertake both the construction and management of railways rather than to attempt to encourage private companies to carry out railway development in tropical Africa. Construction by contract was hampered by the difficulty of any accurate estimate of cost through unsurveyed country, and few private companies were prepared to undertake the construction and management of railways, because even if they had the necessary courage and foresight, they could not afford to lock up their capital for so long or, as would more probably have been the case, have to run the railways at a loss. On the other hand, to have run them at a profit would probably have meant charging such high freights that the development of the country would have been strangled.

Both systems of building and managing railways have their protagonists, and the Report of a Government Committee, published in January, 1924, illustrates the difficulty of discovering the best solution of the railway problem. The actual report was on the means that might be taken to encourage private enterprise in the development of the British Dependencies in East and West Tropical Africa, with special reference to existing and projected schemes of transportation. The conclusions and recommendations of the Committee were as follows:

1. That it is not to be anticipated that private enterprise will be found willing in the present stage of development of tropical Africa to finance, construct, and operate railways there without aid from Government.

2. Owing to widely differing requirements and conditions the Committee did not find it possible to make a recommendation of general application in favour either of departmental construction of railways or of their construction by contract as being invariably the better policy. They pointed out that there is not so much difference between the two methods as might appear at first sight. Under both, most of the material is obtained from private firms, and much of the work is done by sub-contract. The chief difference lies in the fact that with departmental construction the Government employ their own constructional engineer and staff.

The advantages of departmental construction are said to be found mainly in those countries where a programme of railway building, likely to extend over a number of years, makes it possible to maintain an efficient constructional staff. Where this is the case contractors' profits are saved, plans can be modified as necessary, and sections of the line can be brought into use as they are completed, and so earn receipts without incurring contractors' claims. Further, the local government can use existing railways and steamers to help construction, special plant is kept in use instead of becoming derelict, the political staff can procure an adequate supply of labour without dislocating the market, and, generally speaking, the system ensures good team work.

With construction by contract, on the other hand, it is claimed that the valuable element of competition is introduced, that a colony knows the extent of its liability, and that firms of wide experience and reputation can undertake such work more efficiently, rapidly, and economically than a Government department.

The various arguments and opinions of those who advocate one or the other of these two methods of construction are set forth with great impartiality in the Report, but it is unfortunate that the Committee were unable unanimously to make any more definite recommendations than that, when departmental construction is contemplated, tenders for the work should normally be invited and compared with the estimates made locally, that departmental construction should not be permitted if satisfactory tenders are received, and that the test of inviting tenders should invariably be applied before departmental construction is sanctioned.

3. That in the case of harbour works construction should be by contract.

4. That to avoid delays and to enable accurate estimates and tenders to be made, constant progress should be maintained with the detailed survey of future railway routes.

5. That, while the transference of existing State-owned railways to private ownership and management is not at present a practical proposition, Government railway departments should be de-bureaucratized and commercialized. The reforms recommended include:

(*a*) Separation of the railway budget from the budget of the colony.

(*b*) The grant of wider powers to General Managers of Government railways, especially as regards administration, which should be completely separated from the general administration of the colony. General Managers ought, so the Committee considered, to have powers, in the matter of dismissal of inefficients and of pay, similar to those of officials of similar status in railways under private management.

(*c*) The constitution of local railway advisory boards with representatives of the local government and general commercial interests.

(*d*) The appointment of a Railway Inspectorate at the Colonial Office, to which all railways in territories controlled by the Colonial Office should report.

6. That the system of joint ownership of railways by the State and by private companies should be fully explored as a means of enlisting the co-operation of private enterprise in reorganizing existing railways and constructing and managing new railway lines or extensions.

7. That private enterprise should be encouraged to develop light tramways and all forms of road transport as feeders to railways, by the abatement or remission of import duties on vehicles, materials, and fuel, their carriage free or at special rates, and the payment of a bonus per ton on freight brought to the railway.

8. That where additional water transport is required, or where existing Government water transport services may be transferred to private companies, the widest possible publicity should be given to the facts *so as to attract private enterprise.*

In a Minority Report Sir E. Stockton stated that while he agreed with much of the main report he felt himself unable to endorse its general conclusions, because he considered that in East and West Africa a stage had been reached where development must be undertaken on purely business lines, and that neither "paternalism nor exclusiveness" should characterize the attitude of a Government towards the further opening up of territory.

As regards the question of construction departmentally or by contract, he pointed out that the evidence in favour of the first method was given mainly by officials, and that such independent evidence as was given was adverse to this method. He was in favour of tenders for the construction of all future railways being invited, and against a recommendation that a Government should be allowed to withdraw construction from public tender.

The creation of a Railway Inspectorate, Sir E. Stockton considered, would bring into existence another great Government Department, which would be wholly undesirable as tending to perpetuate "the present system of State trading."

He urged a definite railway programme, and saw no reason why, in cases where new lines are urgently required, even the surveys for them should not be given out to contract. Some such lines are needed both in East and West Africa, and their construction is now held up for want of funds. The Minority Report recommended that this should be taken in hand at once and offered to private enterprise, the Government giving a guarantee or other inducement to the firm or company undertaking the work. Alternatively it was suggested that the Government, through the Colonial Office, should arrange for the finance on such lines, calling for tenders for their construction and relieving the administration concerned from the payment of interest for a time.

With respect to the management of railways, Sir E. Stockton recommended the gradual introduction of private enterprise in whole or in part, the railways to be made self-supporting, and to be conducted on business principles.

The two Reports show how difficult is the problem of railway construction and management in Africa, and how hard it is to make recommendations of general application. If it is correct, as Sir E. Stockton stated, that the evidence taken was inconclusive and partial, this Report has merely scratched the surface of a very large field, and it is probably desirable that further evidence should be collected and sifted. That some improvement in the existing system is possible is incontestable, but that the application of "business principles and methods" (a somewhat nebulous and elusive phrase) will solve all the difficulties is at least open to doubt. What is required is a very large capital expenditure coupled with a willingness to wait for some years at least before any interest on that capital is received. These methods have been applied with great courage, and it is to be hoped with eventual success, by the Chartered Company under the influence of Cecil Rhodes and his successors, but it is doubtful whether they can be described as normal business methods. One point is quite clear, and that is that in the expenditure of such capital sums, and in the management of Government railways, there must be scrupulous economy, inefficients must be weeded out ruthlessly, and there should be more elasticity in administration than is perhaps practised or possible under a civil service régime. At the same time, a general desire for administrative economy ought not necessarily to be applied to the management of railways, otherwise there may be reductions in European personnel or non-replacement of rolling stock at the very moment when a territory is increasing the produce to be carried by the railway to the nearest port for export.

Whatever future changes may be effected in African railway administration, and although this paper deals mainly with transport other than by railways, it cannot be too strongly emphasized that *railways are the most efficient and probably the cheapest means of transport for cotton as for other exports, and that tropical Africa cannot be developed with reasonable rapidity without them.* Their effect is moral as well as material, they stand in Africa to-day for what the ancient high-roads stood for in the days of the Roman

Empire, and they should not be considered merely from the point of view of individual territories, but as parts of a general scheme of African transportation.

ROADS.

The developments of mechanical transport are bound to increase the necessity for, and the importance of, roads in Africa, whether they traverse areas infested with tsetse fly or not, and at the present stage it is difficult to foresee whether human carriers, pack animals, or wheeled animal transport will be the first to be replaced by special or improved types of internal combustion vehicles. The cost of petrol is so heavy and the experimental nature of suction gas and heavy oil fuel is such that at present primeval forms of African transport can, and do, hold their own and compete on more than equal terms with mechanical transport, but it cannot be doubted that a time is rapidly approaching when they will be obsolete.

Broadly speaking, African roads are no more than cleared and unmetalled tracks through the bush or across the open veld. Whether the streams and rivers they cross are bridged by culverts or by wooden or concrete structures depends on the financial prosperity of the administration in whose territories they are situated. Where bridges or culverts cannot be afforded, deviations are made, leading to natural fords by easy gradients. In this way steep slopes and high banks are avoided, but in time of floods such roads are liable to be impassable, and in any case may involve going through a depth of two or three feet of water. Bridges and culverts are the important features of African roads, and are more essential than a good surface.

Among the best roads in Africa are those of the Uganda Protectorate, a territory which hitherto has been little served by railways, but whose growing prosperity, derived mainly from cotton, has allowed the development of an excellent system of roads. The Uganda main roads are properly formed and graded, have paved foundations for the wheel tracks, and are surfaced with laterite gravel. As the necessary material is available locally these roads are cheap, and cost only about £400 a mile to construct, and £25 a mile per annum to maintain. This cost includes minor bridging capable of carrying medium-sized lorries. The main roads are open to, and throughout the year are regularly traversed by, solid-tyred motor lorries, provided the gross weight does not exceed 6 tons, while many of the subsidiary roads are capable, during the dry season, of carrying Ford "one-tonners," and can be traversed by ordinary motor cars at twenty-five miles an hour. Both classes of roads are largely used by the motor lorries of the various transport companies which transport baled cotton from the ginneries to the nearest port on the Nile or on Lake Victoria. Naturally they cut up in the wet season, but suffer more in appearance than in reality, and are repaired at the small cost above mentioned.

Few African roads, however, are as good as those of Uganda, owing to the difficulty of obtaining suitable material for foundations or surface. They depend for their wearing qualities on the nature of the soil and the violence and duration of the rains. In dry weather light cars and lorries can use them to a very considerable extent, but unless the latter type of vehicles are fitted with pneumatic tyres such roads are apt to cut up even during this season. During the rains, unless the natural soil is exceptionally stony, they are impassable for wheeled vehicles. Their gradients are steep in many places, and their rough surface puts a very severe strain on the springs of all types of car. On such roads light types of cars or lorries—such as Fords—are the best all-round vehicles. Large-wheeled vehicles capable of carrying good paying loads can be used only where conditions are exceptionally favourable.

Macadamized roads, comparable to those of England, are practically unknown save in the immediate vicinity of large towns, owing to the high cost of constructing and maintaining them.

The foregoing will make it clear that at present mechanical transport on African roads cannot take the place of railways. Even in Uganda, where this type of transport has been most highly and successfully developed, it cannot keep pace with the agricultural progress of that Protectorate, and it has been found necessary to extend the Uganda Railway from the Highlands of Kenya through the heart of the cotton-growing area in the Eastern Province to link up with the line which connects Lake Victoria with Lake Chioga and the navigable portion of the Upper Nile. Roads, however, are essential if the railways are to be fed with sufficient freight to enable them to pay their way, and this is particularly true of agricultural areas. Where minerals are found it is difficult to work and develop them unless a railway is within a comparatively short distance of the mining area, but agricultural produce in exportable quantities implies extensive areas of cultivation which can most conveniently be connected with railways or ports by roads.

The extent of cotton-growing areas and the distance from a railway at which cotton can be grown at a reasonable profit depend directly on transport facilities. Unpressed seed cotton can be carried from the cotton fields to the ginnery by any form of transport ranging from the heads of native carriers to the most modern type of mechanical transport, because it can be made into loads weighing from 60 pounds upwards. The distance over which it is possible so to convey it to the ginnery depends on the type of transport available and the local rates charged for freight. On the other hand, ginned and pressed cotton, with its far greater density, cannot be taken either by carriers or by pack animals from the ginnery to the nearest port or railway, but depends for transport on some form of wheeled vehicle capable of a load of at least 400 pounds.*

Two characteristic but very different instances will perhaps make this point clearer. In Northern Nigeria cotton is brought to the British Cotton Growing Association ginnery at Zaria from a distance of about sixty miles along the Sokoto road from the north-west either on donkeys which carry a load of 150 pounds, or on camels with a load of 500 to 600 pounds. It does not pay to grow cotton, even at its present price, at more than this distance from the Zaria ginnery. At the same time, it is not at present possible to build a ginnery at Sokoto or at any intervening place on the road, because the necessary heavy machinery cannot be transported along the existing road, and even if such a ginnery were built, there is no immediate likelihood of establishing a regular service of mechanical transport to carry the baled cotton to the nearest point on the railway.†

The system of transport in Uganda presents as diverse a picture as can well be imagined. There it has been possible to make a network of excellent roads, and these roads have allowed a very large number of ginneries to be built throughout the cotton-growing area. Some of them are more than seventy miles from the nearest port, but probably none are as large as those which the British Cotton Growing Association has built at Zaria or other places in Nigeria. The development of ginneries has, in fact, kept pace with that of cotton growing. The seed cotton in no case has to be carried over a great distance to a ginnery, while the bales of ginned cotton can be transported by means of mechanical transport working on good roads to lake or river steamers.

Without entering into the thorny and arguable question as to whether cotton growing in Africa can best be fostered by a system of monopoly or free trade and competition, it would seem that large ginneries serving extensive areas both simplify and narrow the problem of transport in that they confine lines of communication to certain definite channels: but they almost compel railway extension or, at least, tramways, road-rails, or some improved system of mechanical transport which can carry heavy loads over unmetalled roads, if new areas are to be cultivated. Numerous small ginneries, on the other hand, divert transport into many small channels and necessitate a comparatively elaborate road system combined with the use of wheeled vehicles to carry the baled cotton.

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* It is a common practice to build small subsidiary ginneries where the seed cotton is ginned and the lint partially pressed into bales of about 200 pounds. These bales are carried in light lorries to the main ginneries to be fully pressed and re-baled.

† The B.C.G.A. are about to build a subsidiary ginnery at Gusau, and the Corporation hope to assist with some experimental motor transport of new type.

To a certain extent the siting, size, and distribution of ginneries are determined by considerations of transport. The difficulty and cost of carriage may be so great, and the local value of cotton seed so little, that it will pay a ginner to extract the seed at a small outlying ginnery, and to transport to a main ginnery for full pressing and baling only the hand-pressed lint of cotton grown at a distance. But there are other considerations to be borne in mind. The overhead charges of small ginneries are relatively far heavier than those of large ones—that is to say, of ginneries capable of dealing with not less than 10,000 bales per annum. Small ginneries also may complicate the arrangements for seed distribution, which, in areas where cotton is grown by natives, must certainly be controlled by the Agricultural Department in order to minimize the risk of bad or mixed seed being sown and the reputation of the local cotton being damaged in consequence.

The foregoing notes on existing transport conditions, although of necessity incomplete, may perhaps suggest some of the requirements of the ideal mechanical transport vehicle for tropical Africa. In the first place, since most African roads are unmetalled, the weight on the axles, or, in other words, the pressure per square inch on the road surface, must be low, in order that the roads shall not be cut up in wet weather, and if possible the action of the vehicle should actually consolidate and improve the cleared track. This result may be achieved by the following means:

1. By using light vehicles.
2. By increasing the number of wheels.
3. By increasing the width of the wheel treads.
4. By enlarging the diameter of the wheels.
5. By substituting some system of caterpillar action or continuous track for wheels.

1. The possibilities of light cars, such as "Box Fords," were very fully explored during the late war, when they proved of the

very greatest value from a military point of view. In some areas the use of any mechanically propelled vehicle more powerful than a 1-ton wheeled lorry is actually prohibited by the local administration in order to save the wear and tear of the road surface. There is no doubt that light lorries, and especially Fords, have proved most successful, for they can negotiate tracks which were believed to be impassable for any type of motor car, but the light car has very definite limitations. Its load is very small, and each small load requires a separate driver, and the running costs per ton-mile are high. Moreover, it has not sufficient power to go through sand or over heavy and boggy ground. It is difficult to see what developments of this type of car would make it a more effective and *economic* means of transport than it is at present.

2. Reduction of axle weight by increasing the number of wheels is, of course, a common practice with railway vehicles, which are mounted on bogies; many large lorries or trailers also in this country are fitted with six wheels.

The latest and most elaborate development of this principle which has been actually tested is a 13·5 h.p. Renault chassis fitted with three axles and six wheels; of these six, four are driving wheels with two driving axles, each with its own differential. The arrangement of these wheels allows considerable freedom of movement, so that if one wheel passes over an obstacle, such as a stone on the road, the other three remain in contact with the ground. Each wheel is, moreover, a twin, consisting of two rims bolted together, and the weight of the car is therefore carried on twelve tyres, all of which are of the "balloon" type. This car has been proved to have great adhesion and a remarkable capacity for getting over ground where an ordinary motor car would be completely "stalled." The objections to it are the cost of its twelve large tyres, and the fact that being a wheeled vehicle, its further developments appear to be limited; moreover, the wheels, although the weight on them is small, are unlikely to improve and consolidate unmetalled roads.

3. Wide wheel treads are a normal feature of the modern lorry, and the final and logical conclusion of this development would be something akin to a road roller. So far as the writer is aware, no developments on this line for commercial and tropical transport work have been successful, and they are, indeed, improbable, for this type of vehicle would not be likely to have that adhesion which is essential in order to negotiate bad gradients and difficult places in a road.

4. The commonest example of the large-wheeled vehicle for bad roads is the American "buggy," and there have been several experi-

ments with large-wheeled motor vehicles which have proved that they are very effective for cross-country work. Here, again, the possibility of development is limited, and although such vehicles may be effective in crossing ploughed fields, it is doubtful whether they would prove satisfactory for unmetalled roads whose surface it is essential they should not damage or make impassable for light passenger cars.

5. The caterpillar or track system. Various types of track vehicles have been built during recent years, of which the most familiar is probably the "Tank" used during the war. In addition to the very high road resistance, one of the great difficulties with this type of vehicle has been to obtain an efficient system of steering. The method of steering the tank, for instance, when one track moved forward while the brake was applied to the other, although permissible for purely military purposes, is undesirable in a commercial vehicle intended for any road or unmetalled track which must not be cut up, though it should be noted that the low road pressure of the modern track vehicle makes it possible, within limits, to skid with comparatively little damage to an unmetalled surface. The most promising development up to the present has been the construction of "half-track" vehicles, in which the front wheels are retained for steering purposes, and the rear wheels are replaced by a flexible double-track system. These two tracks carry most of the weight of the vehicle and load. The writer of this article is not competent to describe technically these "half-track" vehicles, of which the best known is the Citroen Kégresse, in which a successful journey across the Sahara was made recently. Broadly speaking, however, the weight is carried on a revolving endless track of rubber, or linked metal plates. The lower portion of the track is in contact with the ground, and in consequence of the considerable length of track which rests on the road, the pressure per square inch of road surface is very small—*i.e.*, from 5 to 20 pounds, according to the type and size of vehicle. On the inner side of the track are two or more wheels which roll on the track as it revolves and is automatically laid down for them. It is claimed for such vehicles that, owing to the low road pressure, they can not only travel over, but actually improve and consolidate, soft ground, and there is no doubt that there is considerable justification for this claim. It is also certain that they can negotiate very steep gradients, and that their draw-bar pull is far greater than that of a similar vehicle on wheels. On the other hand, tracks have not yet been "proved" in regard to maintenance under commercial and tropical conditions, and it is probable that an

" all-track " vehicle would theoretically, at least, be an improvement over a " half-track " one if only the difficulty of deflecting the track so that it can follow a reasonably sharp curve without skidding action and consequent destruction to the road surface can be overcome. The writer has little doubt that further experiment will lead to the production of an efficient track vehicle which can carry and pull far greater, and therefore more economical, loads over unmetalled tracks than has hitherto been found possible.

This will in itself be a marked and notable advance towards the solution of the African transport question, but there remain several other difficulties to which the attention of motor engineers may well be drawn. Of these the chief, from a commercial point of view, is the expense of petrol in Africa. He would be a bold man who would assert that mineral oil will not eventually be discovered in the continent, but it has not been found there yet in paying quantities, and until the amount of freight carried on the railways is very greatly increased, the cost of petrol at any distance from the coast is bound to be heavy. It is highly desirable, therefore, that the experiments of using heavy oil or suction gas produced with charcoal as fuel for internal combustion engines should be continued.

Another form of fuel, which promises advantages, is denaturized alcohol. This can be made from many vegetable growths, and there would probably be little difficulty in manufacturing it locally. If made and consumed on a large scale it would almost certainly prove cheaper than petrol.

Further, the writer suggests that in hot climates it may be advantageous to develop air-cooled engines. He is not aware how this would apply in the case of large engines suitable for lorries.

WATER TRANSPORT.

No paper on transport in Africa is complete without a reference to water transport. The three lakes, Nyasa, Tanganyika, and Victoria, together represent a stretch of over 900 miles from north to south. The navigable portion of the Nile above Khartoum stretches for 1,000 miles to the northern Uganda border, and there are many other rivers, notably the Niger, the Congo, and the Zambesi, without which, as lines of transport and communication, the exploration and development of Africa would have been delayed for many years.

At the present time the most important of the lakes from the point of view of cotton is Victoria, to the ports of which the cotton grown in Uganda is now carried for transport to Kisumu, the present terminus of the Uganda railway. This railway is, however, now being extended through the centre of the cotton-growing area, and in a few years it will be possible to transport most of the Uganda cotton direct to the coast without any transfer from steamer to train. From the Mwanza district of Tanganyika, another great potential cotton field, the lint is, and will be, carried across the lake to the Uganda railway until Mwanza is linked with Tabora on the central railway between Dar-es-Salaam and Lake Tanganyika.

Nyasa alone of the great African lakes is not connected with the sea by railway, as the line has not yet been extended northwards from Blantyre, and in any case there is a break at the Zambesi, which has not yet been bridged. In these circumstances it is possible that there may be some settlers in Nyasaland who regret the days when their bales of cotton and other agricultural produce were carried leisurely if comparatively cheaply to the port of Chinde down the Shire and Zambesi Rivers in their seasons of spate, and prefer old-fashioned methods to the modern and expensive luxury of a weekly train to Beira.*

The shortcoming of the smaller African rivers as lines of transport is their seasonal fluctuation, but there is no doubt that where they are permanent they provide very cheap and satisfactory lines of communication for goods that do not deteriorate by delays. If an increase of population will admit of the cultivation of rain-grown cotton in the southern Sudan, the importance of the Nile will become even greater than at present. It will be the main trunk line, and the transport problem of that region will lie in the development of feeder lines and roads to the river. Some such roads have already been built, and there are good motor roads from the Belgian Congo both to the Nile and to Lake Albert.

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* The railways from Blantyre to the Zambesi, and from Zambesi to Beira are not administered departmentally.

SOME THOUGHTS ON LAND TENURE IN TROPICAL AFRICA

BY

H. MARTIN LEAKE, M.A., Sc.D.

Not the least among the areas now being developed in order to obtain additional supplies of cotton lie in Tropical Africa. From the north through the Sudan, from the east through Tanganyika and Nyasaland, from the south through Rhodesia, and from the west through Nigeria, the centre of the Dark Continent is being penetrated, while, in the interior, Uganda is already opened up, and active development is also in progress in Belgian territory. In all these countries the indigenous population is of a primitive type, organized, for the most part, on a tribal basis with more or less well-defined tribal spheres of influence. The relationship of the people to the land is nebulous. Intertribal strife and disease have hitherto taken their toll, and nowhere has there been attained a density of population sufficient to compel the crystallization of this relationship into a definite system of land tenure. The peace which follows penetration by the white man, the fight against disease which is one of its concomitants, and the increase of wealth which results from development in tracts subject to that penetration, all tend to produce a rapid increase of population with a pressure on the land which, sooner or later, and in many cases sooner, will compel the adoption of some more concrete system if the path of progress is to run smoothly in the future. It is not a matter for doubt that the question of this future land tenure system should be settled in its broadest aspects at a very early date. For, just as a microscopic crystal may determine the form in which a substance will be deposited from solution, so the essential features of divergent systems of land tenure are traceable even in the most elementary stages; what at the time may appear an unimportant decision will, not improbably, determine along which line the future policy of land tenure will proceed.

But while this question of land tenure will be inevitably raised by the compelling force of population, this force is comparatively slow in action; for, immigration being ruled out, it can only arise with natural increase. There is likely to be, and, in fact, there has already arisen, another force, the action of which will be much more immediate in its result. This force originates in the insistent and increasing demand of the world for wealth, primarily in the form of raw materials like cotton. Cotton is not the only commodity for which the world's demand is leading to the penetration of new regions; cocoa and coffee exert the same influence, while minerals have in the past led, and will continue in the future to lead, to exploitation of such regions. This external pressure, especially when it is exerted by the demand for agricultural produce, must necessarily react on the land question. In the presence of large expanses of waste, but fertile, land, and in the absence of adequate population, the obvious and simple method for the immediate realization of the latent wealth is extensive farming, with all the paraphernalia thereby implied. This, however, is a development which only becomes possible with the employment of external capital, and capital demands guarantees. At once the most satisfactory of guarantees to possess, and at the same time, the simplest to give is a lien on the land; at this stage it costs nothing in the giving, and no very material interests are affected. And herein lies the danger; for when the slower acting force of population begins to exert itself, there remains no outlet for a population now landless, but working for a wage. Nor is this danger a remote one. Capital is alive to the advantage of the possession of land; it does not take into its calculations merely the value of the produce which is recovered as the immediate result of its intervention, it takes into account also the appreciating value of the land itself. Moreover, capital is available in sufficient abundance to create in many cases a land boom in which the " incremental value " becomes the primary, and the production of material wealth the secondary, interest. Nor is this action, indeed, confined to the external capitalist. Rarely are the indigenous races so completely backward that none among their component individuals realize the possibilities of the situation. With such people the acquisition of material wealth may cease entirely to be of interest, in which case land acquisition becomes purely a matter of speculation, a means of reaping the incremental value without labour; or they assume the position of absentee landlords and, by a system of rack-renting, attempt to divert the profits of production to themselves at the expense of the tenant.

The harmful, not to say disastrous, results which must follow either development require no emphasis; they can be avoided only by a clear and defined policy with regard to the land, thought out ahead, and consistently applied. That policy must take account of essential facts: the external pressure due to the world's demand for increased supplies, and the relatively slow rate of unaided internal development. The employment of external capital appears inevitable; nor need its employment raise fears if the dangers inherent in that employment are recognized in advance. The potential wealth is such that there is sufficient to repay handsomely all those taking part in its acquisition, and it is the function of the administration to see that the stronger party does not, in the early stages, monopolize the proceeds. Co-operation between the indigenous population and its rulers has accomplished wonders in many directions, but there is an obvious limit to the scope of official co-operation. What is required is an extension of this co-operation to an external element capable of meeting the capital requirements of development. The key to the position is, as I believe, to be found in the land policy.

In practice the question of land tenure is usually approached administratively from one of two directions. The local system may be adopted and developed, or preconceived ideas, based on systems foreign to the country of application, may be put into practice; not infrequently one system is adopted at one stage, and the other at a later date. Both systems, if rigidly applied, have their defects. The local system is frequently unsuited to the modern environment with its rapid transport and world-wide markets. Localization of crops, large units of cultivation, and marketing in bulk, are all better adapted to such conditions than are the small self-contained units so typical of primitive communities. Typical of the development of the former system is that found in Moslem countries where the law of primogeniture does not hold, and where, on a man's death, his property is divided up amongst various relatives, many of whom would not be considered in English law as having any claim upon the estate. I may instance as examples the Nile Valley and certain of the more densely populated parts of India. Pressure of population can, under such circumstances, produce only one result: minute subdivision, with the ultimate and inevitable goal, the uneconomic holding. On the other hand, a blind adoption of the latter system may be equally disadvantageous; unless introduced with a clear appreciation of the local conditions and modified accordingly, direct conflict may arise between local and foreign ideals and customs. A case of such an imposition is to be found in the permanent settlement of Bengal, where an attempt, ill-advised as the result has shown, to build up a yeoman class comparable to that typical of a certain stage of English history, has not only failed to accomplish its object, but has led to results which now, over a century later, raise a constitutional problem of no mean order.

In the present article I propose to adopt a detached attitude; to discuss on general and theoretical grounds the major considerations bearing on the question of land tenure, and to deduce therefrom the system which appears to be most suited to the object in view—the extraction of the maximum amount of wealth from the land, with a simultaneous assurance of the moral and material development of the native races. Such a system will then form a goal towards the attainment of which the development of the land-tenure system should be directed. It will then remain to be seen how far, starting from local custom, that system can be attained without any violent shock to that custom. By such means it may be possible to avoid complications in the future, such as must otherwise inevitably arise. For conditions change; in the early stages the administrative problem is commonly the attraction of population and their settlement on the soil. Systems intrinsically sound under these conditions become uneconomic and frequently oppressive when a pressure of population begins to assert itself.

To keep the issue in its simplest form I exclude from consideration those portions of the continent which are, on climatic grounds, a "white man's country." I am here mainly concerned with the issue in cotton tracts, for it is in them that the question may become acute in the first instance, and the optimum conditions for cotton are not those under which the white man will readily undertake manual labour in the field or rear healthy stock.

If I were to attempt to define the aim of development in an agricultural tract I might, I suppose, say that it was to realize from the land that amount of produce which would, after meeting the needs of the producing population, leave the maximum residue for the consumption of others. There are here indicated two variable factors, a population and a bulk of produce, and there can be little doubt that there is an optimum density of population which would best achieve this ultimate aim. This, however, assumes the establishment of a static condition, and, as is only too obvious, such a condition is unobtainable, for there is invariably a tendency in a healthy community for the population to increase. Herein is to be found the reason why no rigid system can be evolved which will, in any tract, be suited for all time. Herein, too, lies the danger in opening up new tracts. These usually lack sufficient population, if they are not actually unpopulated. The pressure of circumstances compels early development to take as its aim the attraction of population; but a time will come when the optimum density has been reached, and then such an aim becomes inappropriate and even harmful. We have, therefore, to visualize development as composed of a series of stages, each of which, while aiming at momentary adjustment between population and production, is but a step to the higher stages. The static condition must be replaced by an evolutionary process exhibiting no marked break of continuity, and our land-tenure system must admit of such an evolutionary process. Clearly cases may arise where the immediate adjustment can only be attained by means which are definitely antagonistic to the line of evolution. In such cases the immediate benefits must be weighed against the prospective disadvantages, and action taken accordingly.

In this condition of flux there is only one definite and strictly limited factor, the land, which thus appears in marked contrast to the population. Development, consequently, will take a definite course; at the commencement, primitive methods and the expansion of population met by an extension of area under cultivation, giving place later, when the limitation of area begins to be felt, to a gradually increasing intensity of cultivation with the adoption of improved methods. Long before the latter stage has matured, however, the differing qualities of land will have given to the more productive portions a definite value in the eyes of the people, and questions of ownership will have arisen. The problem, thus, is to determine what system of ownership is best suited to the passage from one stage to the next, while fulfilling, as far as possible, our definition at each stage of progress.

What, then, are the requirements essential to the achievement of the aim of development as defined above? In the first rank I would place peace and order, both external and internal. These are obtained only by a strong central authority, the outward and visible signs of which are an army, a police force, and a judiciary. Inasmuch as these require money for their maintenance, we must add to them a tax-collecting force also. The second requirement is money for development—in other words, capital. But capital is of two forms. One of the aims of development was stated to be the production of a maximum residue after supplying the needs of the population. Such a residue enables the population to satisfy its needs and desires for objects which cannot be produced locally; and it is for this purpose only that such a residue will be produced. Clearly also there must be a system of transport by which this residue can be carried to outside markets. In the tracts we are considering these markets are distant and the lines of communication are long. Capital on a large scale is required for such schemes which, to be effective and satisfactory, must be co-ordinated. On both accounts a central authority is requisite. As another class of schemes requiring for like reasons a central authority, I may instance irrigation works. A further reason for relegating such schemes to a central authority is that, in the majority of cases, they cut across several tribal spheres of influence; the knowledge and co-operative spirit necessary to supply the stimulus to development from within is lacking, and must be applied from without.

Passing to a more restricted field, we have need for capital to supply the ordinary implements of the field and the working cattle; to make permanent improvements to the land, such as clearing and levelling, to sink wells, and to build dwellings. Between these two classes of capital no clear line can be drawn. The essential consideration in making a distinction, and the consideration I would emphasize, is the source from which that capital would be attracted, whether from the individual responsible for a unit of cultivation, or from an impersonal body not immediately concerned with the art of cultivation. Clearly, on this consideration, the line of demarcation will be drawn much higher in the case of large holdings, such as are characteristic of England, or the prairie lands of the American Continent, than in the case of holdings of a few acres, or even fractions of an acre, characteristic of the rayatwari tracts of India.

To complete our survey of requirements for development, we may add to these two essential forms of capital a third. Between the production and disposal of excess produce, time, and in fact, considerable time, must elapse; in addition to expenses during the course of production the costs of packing and of transport have to be met, and are only recouped after sale. All these charges can only be met by a certain amount of floating capital, if the full value of the produce is to be realized. The main business of marketing is, of course, the function of the merchant, but, as in the former case, it is difficult to draw a sharp line of division between the capital which is properly supplied by the producer and that which it falls to the merchant to provide. Here, again, the line of division will vary according to the exact status of the producer.

I have so far indicated two bodies only as essential to production: a central authority, commonly called Government, responsible for peace and order in the widest sense, and a cultivating community responsible for actual production. We have to consider whether these two bodies alone are in a position to meet the capital requirements of development. Clearly a responsible and well-established central authority is in a position to make capital provision for work of the major class. It may do so directly by loan or indirectly through agents, who receive concessions of a sufficiently attractive nature. At the other extreme, even the small-holder is usually in a position to provide the implements of agriculture, especially when they are of the very primitive type found in Tropical Africa. Whether he is in a position to provide seed of good quality, strong cattle for cultivation, capital for levelling and, perhaps, draining his land, is more open to question. That he is in a position to market his crops with full benefit to himself is certainly not a fact. From this aspect the crucial question is the source of this capital. Clearly the central authority is not in a position to step in and provide such capital; apart from practical questions of control which such a step would involve, it is without doubt not the function of a central authority to provide capital to meet development of the social unit. We are here faced with what is a world-wide problem, the problem of agricultural indebtedness, and it must be met in one of the ways which have afforded a solution elsewhere.

Not the least of these ways is co-operation. Stated briefly, co-operation is the union of large numbers of individually small and financially negligible units into larger ones and the linking of these to form a system which gives to them a stability and security which will attract capital both from their own units and from the world's supply. Co-operation has been a powerful force for the provision of capital in many countries, but its success appears to depend on some elusive temperamental characteristic which is the possession of some races only. It is very doubtful if this characteristic is possessed by primitive races. Moreover, enthusiasts are accustomed to claim for the system an educative value. So far as my personal experience has gone, the educative value is only attained when the control is in efficient hands, in which case the system ceases to be co-operative, or its working is marked by an inefficiency which renders the organization of doubtful value. Rarely can two birds be killed with one stone in this simple manner. It would appear that a certain minimum, and that a somewhat high minimum, standard of education is required to develop co-operation effectively, and there can be little doubt that such a standard has not yet been attained by the primitive tribes under discussion.

With the exclusion of co-operation as a practical solution of wide application, the line of argument I have followed has developed the need for a third agency, the chief function of which will be the provision of capital to be devoted to the development of the unit of cultivation, as well as of floating capital required for the earlier stages of marketing. Before, however, any individual or group of individuals will make such provision, one essential must be forthcoming—namely, security, and there is only one method of providing that security. The supplier of the capital requires some reversionary power over the products of the expenditure of that capital, which, as these are inseparable from the land itself, implies a reversionary interest in the land itself. The third party, in other words, must occupy to a greater or less extent the position of landlord. The problem begins to take a more defined shape, and may now be formulated as the determination of the position which this third party should occupy in the system of ownership.

To arrive at a solution of this problem we must turn for a brief moment to a consideration of the principles which are involved in any discussion bearing on the land, and, maintaining for the time being our detached attitude, we will consider this in its widest aspect. What has come to be known as the economic doctrine of land is based on the fact that, as already mentioned, land is a form of wealth which cannot be multiplied by human exertion; in consequence it asserts that private ownership of land is not justified. Its value is determined, as in the case of other commodities, by demand for use, and payment of this value for the privilege of use should be exacted not by an individual, but by the community. Virgin soil, as such, has small productive value; enhancement of the value of any particular piece of land is due to two causes: (1) development of the land itself, due to the personal initiative of him who has paid for the privilege of use, a cause intrinsic to the land itself and dependent on the will of the possessor; and (2) development of the area in which the land lies, a cause extrinsic to the land itself and independent of the will of the possessor. The economic doctrine recognizes that the provision for the development of the land itself is best provided by private agency; it recognizes that "the surest way to bring about the abundant production of wealth is to secure to the producer the free disposal of what his exertions have produced," and it recognizes that capital will only be forthcoming if security and a fair return on any capital so employed be established. While, therefore, it would leave any incremental value arising from the first cause to the possessor it claims that the incremental value arising from the second should accrue to the community. Incidentally it recognizes the duty of the possessor towards the community, and exercises on him a certain compulsion to develop the intrinsic value through the need of paying to it the incremental value due to extrinsic causes.

The economic doctrine is hardly open to criticism on general grounds. Its practical adoption is a different matter, and bristles with difficulties. These difficulties, however, are less inherent in the system than based on vested interests which have their origin in established systems. None except an iconoclastic Government would sequestrate, without compensation, rights legitimately acquired under an accepted system and, if compensation is to be entertained, the advantage of a change of system is largely, if not entirely, annulled. Where, however, population is so scanty that land possesses no immediate value, there is little doubt that the economic doctrine affords the soundest basis for a land-revenue system. Its adoption in principle in areas such as we are here considering, where pressure of population has not yet given land any appreciable value, is almost certainly sound. Its adoption, however, involves certain consequences, not the least of which is an accurate valuation of the land, of development, and of incremental values; it involves, in other words, a controlling authority which must be widespread and efficient if individual units of cultivation are to be considered separately. That such a complex organization for effecting the valuation can be maintained in primitive countries is very questionable. Again, a need arises for a larger unit than the individual cultivator with which the central authority can deal; the economic doctrine—that is, when applied to the primitive conditions we are considering—seems to require for its application a landlord. He will be, however, a landlord in a very different sense to the landlord of English conception. He will be subject to an incremental tax, in reality a rent, levied by the central authority, and he will be an intermediary between the actual cultivator and the central authority, thus assuming, in part, the position of a tax collector. But while this position holds good, it remains only one of his functions, and his establishment as a mere individual to whom the collection of a land revenue has been farmed out must at all costs be avoided.

The word " landlord " bears so well-defined a sense in England that its use here may be misleading. It will be well, therefore, to emphasize the difference between the landlord's position under the economic and English systems. I can best do so by a brief reference to the system of Northern India. This system, instituted by Akbar, is based on a " settlement " which may be defined as a determination of the share of the produce to which the State is entitled. In many parts, such as Oudh, the collection of this assessment was farmed out, and a class of tax gatherers was thus established. With the breakdown of the central authority the tendency was for power to pass to these tax gatherers and, on the occupation of the country by the English, their true position was not appreciated. Imbued, as the rulers of that time were, with the English system, these men were in many cases accepted as landlords with proprietary rights in the land, subject only to the payment of the revenue assessment. Over the major portion of Northern India this assessment was, and remains, subject to periodic revision, and we have an approach to the economic system, the assessment taking the form of a rent which takes into account incremental values. It fails, however, to meet the full conditions of the economic system in that the enhancement is calculated on the entire incremental value, and not on that due only to extrinsic causes. In Bengal, Bihar, and parts of the United Provinces, however, the application of the English system was, in 1793, carried still further when the assessment was made permanent and unalterable. The economic system is here represented only by the small tax, the whole of the subsequent incremental value going to the landlord.

Effective development, whether considered from the purely economic standpoint or from the standpoint of the need for capital, demands, thus, a third party who will be in the position of tax gatherer in respect to Government and of landlord in respect to the actual cultivator. We have now to consider in greater detail the relationship between this " landlord " and the cultivator which will be most likely to achieve our object. There are, broadly, two systems: that which we may term the capitalistic system, in which the " landlord " himself cultivates large areas and employs paid labour to carry out the work, and that by which he leases the land in small-holdings of a size which can be cultivated directly by individuals or by small individual groups, such as the family. The first system may be more productive in the early stages, and there is, consequently, frequently a great temptation to resort to it, but it can hardly be doubted that it will not remain for long suited to the needs of an expanding population which has no industrial outlet, and must be supported on the land. On moral grounds, too, it partakes of the essence of wage slavery of which so much is heard nowadays. The second system would appear to be the one most suited to existing African conditions, but it, too, is obviously open to abuse. Particularly is this so when population begins to exert a pressure on the land with a consequent rise in rents. In such circumstances the " landlord " may find a life of idleness more to his taste; in this case he becomes non-resident, and the rents are collected by a bailiff. In the result we have all the evils of rack-renting.

This, however, is the reverse side of the shield, and there is another. Suppose he remains resident; suppose he invests his capital in the land and its improvement; suppose he advances seed, manure, and so on to his tenantry, and suppose he sells the aggregated produce collected from his tenantry so as to secure, in part at least, the profits resulting from bulk handling, and divides these between his tenants and himself. He will, if he do these things, do more to attain our object of securing the maximum of excess produce than could any other person or organization. The system at which we have now arrived will be at once recognized; it is the métayer system of France and the Continent. Its strength and its weakness will also be recognized: the personal interest of the " landlord " in his estate, and his contact and association with his tenantry are essential to success.

The organization which the preceding arguments indicate to be best suited for agricultural development involves a triple partnership composed of a central authority as representing the community, a " landlord," with a prescriptive right to the land so long as he pays the assessment, and a cultivator. The relationship of the two former is that of landlord to tenant, the true economic relationship, the central authority taking a rent for the use of the land, and a rent which is subject to fluctuation. It would absorb any incremental value due to causes extrinsic to the land itself, and exclude such value when it is due to developments dependent for their initiation on the possessor. The relationship between the two latter is one of co-operation, the " landlord " providing the capital required for development and receiving his interest partly in enhanced rents, but especially in his share of the excess produce. We have now to see how far this idealistic scheme is compatible with local conditions and whether there is anything in it antagonistic to local custom. In the first place, we may consider the attitude of local custom towards the land.

This point may be dismissed in a few words. It appears to be the rule throughout Tropical Africa that the land belongs to the tribe, the chief of which " allots unoccupied lands at will, but is not justified in dispossessing any family or person who is using the land." Further, " conquest vests the control of the land in the conqueror." The way is, therefore, wide open for the introduction of the economic system. But if we omit certain centres which have assumed an urban condition, and if we limit ourselves to the consideration of purely agricultural tracts, density of population is, as a rule, insufficient to give an economic value to the land, for no economic value can exist when a commodity is in large excess of the demand. The central authority, however, requires funds and, if it is to rely for these on the economic rent, it must establish conditions which will give a value to land. This it would appear to be in a position to do while acting in strict accord with native custom. As ruling authority, it is in a position to claim all land as belonging to the State; of occupied land it will recognize the inalienable right of the possessors subject to the payment of the assessment, and of unoccupied land it will claim a right to disposal. By such action it can not only adjust the release of land to meet the needs of a growing population, but it can take under its own charge and develop as forest areas unalienated lands. It can thus establish an economic rent, possibly only a small one, immediately, and at the same time protect and develop in the interests of the community, and, in view of the rapidly constricting forest areas, in the interests of the world at large, those areas not required immediately for agricultural settlement.

Before, however, the revenue derived from the establishment of an economic rent is likely to become appreciable, the administration will require funds. These can only be found in one or other of the many ways now used. We have here no direct concern with these ways of obtaining funds, except in so far as it appears desirable to indicate their real nature, and thus to facilitate their substitution by an economic rent as soon as the volume becomes sufficient to provide the administrative needs. Head, hut, and cattle taxes are in the nature of an income tax, and form a convenient rough-and-ready method of estimation and of equitable distribution of the burden. The Koranic tax of one-tenth of the produce falls into a different category, and is of the nature of a tithe. Clearly it covers in part the economic rent, since it would include the value which attaches to the produce owing to extrinsic causes, such as the cheapening of transport by road or rail construction. But it covers also the value which attaches to that produce owing to intrinsic causes, and is, to this extent, an unsound tax. It is open to objection on other grounds, in that it is the application of the métayer system as between Government and cultivator. Experience has shown that an equitable application of this system is only obtainable so long as the landlord retains a personal interest in the land and its development, and that it breaks down when pressure of population forces up rents and makes it possible for the landlord to draw a fair income from those rents while absenting himself. As between the cultivator and an impersonal partner, the State, which of necessity must work through agents, the system is impossible. It is unnecessary to dilate on the openings which lie to the hand of a staff, having no direct interest in the result, which must be large if the detailed yearly or seasonal valuation is to be carried out expeditiously, and will probably be ill-supervised if the cost is not to be prohibitive. These taxes, therefore, should be replaced as opportunity occurs by an economic rent, for this requires no such staff and no such detailed work, since the annual valuation of produce which should be placed on the market expeditiously will be replaced by a periodic settlement. This the presence of a third party renders possible, the function of that third party being in the nature of a buffer by which the financial shock of bad seasons is absorbed.

There appears, then, to be nothing in native custom antagonistic to the introduction of an economic rent; in fact, the native attitude appears to be in remarkable accord with the economic doctrine. The second essential to the scheme we have arrived at on theoretical grounds, an intermediary between the central authority and the cultivator, must now be discussed. The organization commonly in force has been described as tribal. With the omission, for the moment, of the central authority recently superimposed on the indigenous population, tribal authority centres in a chief who rules over a greater or less area. In his hands lies power over the land—to give, but not to dispossess. Subordinate to him, and according to the extent of his sphere of influence, come district and village headmen. The unit is thus communal, the village, and there is nothing to correspond with the estate unit such as the landlord system, even in the modified form here outlined, demands. The class, in fact, has to be created.

This organization is, without doubt, temporary. With development land will certainly acquire an economic value, and the inevitable result will be the speculative acquisition of land. It is more than questionable, however, whether a landlord class so originating will benefit the country; experience gives a very clear answer on this point. Either the landlord becomes absentee and rack-renting results, or he dispossesses the local population, who then occupy the position of wage earners. The landlord whom we have in view will not arise in this manner, and it becomes the function of the central authority to see that these two forms of landlordism do not arise. Dispossession is easily guarded against, though care must be exercised if other evils are to be avoided, but rack-renting offers a far more subtle problem.

Where the " landlord " of the type we have visualized is to come from is hardly a matter for generalized consideration, depending as it must on individual characteristics which differ from race to race. The main generalization is that the community is a graded association, passing from the chief through the district and village headmen to the family and individual cultivator. Across this continuous series a line has to be drawn somewhere, the organization above forming the administrative agency and that below the productive agency. It will be in the uppermost rank of the latter that our " landlord " must be sought. Under this generalization the position of the chief is clear; he falls naturally into place as part of the controlling authority and, as such, he forms a unit through whom the external authority will work. The conclusion that our " landlord " is not to be sought among the chiefs is sufficient for our purpose, and I need here only point out that this conclusion is in agreement with the views so ably pressed by Sir F. Lugard. The same argument applies to the district headmen; their status is rather that of an executive authority or agent than of a potential landlord. Though there is nothing to prevent them holding the dual position, their primary function will be executive. In the case of the village headmen, the argument is not so clear, and it is possible that they may provide recruits for a landlord class, but my own view tends to associate them as a class with the executive, while recognizing that individuals may assume the position of landlords.

The conclusion, then, is that a landlord class in the sense indicated does not exist, and if we are unable to indicate with any certainty whence it will arise, we need not be unduly alarmed. The conclusion itself is not surprising, for landlordism becomes a desirable object only when an economic value has come to be attached to the land. That such a class will arise is inevitable, and it is the function of the central authority to direct progress so that that class, as and when it arises, may be guided to fulfil the function allotted to it. With this object possession of the land should be accompanied by sufficient restrictions to ensure avoidance of those abuses which are known to arise when pressure of population has given to the land a value that is real. Especially should those restrictions ensure a perpetuation of the small-holdings system; freedom to sell must be granted, but should be subject to restrictions which will safeguard the interests of the tenant on the one hand, by the recognition of a certain fixity of tenure, while the interests of the landlord on the other must, in like manner, be protected from the evils of too intense partition. These are points which it is impossible to discuss here, and attention can only be directed to them.

It will take us too far from our subject to deal in any detail with the educational aspect which these problems raise. The conclusion that a " landlord " class has to be created, however, gives to the educational problem such a direct interest that I cannot pass it over in complete silence. In the discussion of educational matters, as it appears to me, two vital considerations are usually overlooked. The Americans alone appear to recognize that a relation must exist between education and the economic standard of living. An educational policy which is based on literature and the humanities is ill-suited to the needs of a population which has to live on and by the land. Again, a policy which aims at the production of a highly trained and somewhat specialized class is unsound if applied to the community as a whole. Educational experience shows that any random collection of students falls naturally into three groups: a comparatively small group composed of students of an intelligence well above the average, a similarly small group composed of students of an intelligence well below normal, and a third, and by far the largest, group of about average intelligence. The only sound policy for general education will be that which aims at best fitting this large group of average students for their normal work of life—namely, the earning of their daily bread. Unfortunately, in the case of such populations as we are considering, when they first come under British jurisdiction, the obvious need is for a clerical staff to carry on the work of administration, and educational policy inevitably assumes a literary basis as being best suited to meet this need. Further, the high standard of efficiency sought after forces the standard up to a degree from which the brightest students only can derive benefit. The advantage of a highly educated and efficient administrative staff is undoubted, but the price paid is too high if this efficiency can only be obtained at the expense of the mass of the population.

Omitting the question of primary education which the mass of the people require, I visualize the more advanced type of education best suited to the conditions to be that which will have as its main object the training of the more influential section of the population, to which such education should, in the first instance, be limited, to fulfil their productive function in the economy of the country. In an agricultural community this function is, undoubtedly, that of a " landlord " in the sense in which we have used the term. It is possible that there would be a certain decrease in administrative efficiency, but this evil, if evil it be (for administration is a good servant but a bad master), is incomparably the lesser one. Moreover, this decrease of efficiency is by no means inevitable. The average life of any community or of any class of a community is of necessity somewhat humdrum, and it is far from improbable that any educational policy directed to meet average needs will throw off the more intelligent as judged by other standards. It should not be impossible to provide an outlet for these and render them efficient administrative officers. My plea, thus, is for a reversal of the order of educational aims as usually accepted; a fitting of the average student for a productive after-life is placed in the forefront of the educational policy.

I proposed at the commencement of this article to discuss the question of land tenure in those countries, mainly in Tropical Africa, which are likely to be affected by the demand which exists at the present time for larger supplies of cotton. That discussion has led us to develop a scheme which postulates the existence of a class, the " landlord " class, which does not exist. The raising up of such a class is a question of education, and will necessarily be a slow process, too slow, in all probability, to meet the insistent demand for more cotton. Such an insistent demand takes practical shape in high prices, and such high prices form the attraction for the capital on which development depends. The slow process we have outlined, therefore, seems likely to be anticipated by a development based on capital introduced from without, and the scheme of development at which we have arrived, consequently, exposed to a somewhat rude shock from the introduction of a fourth interest—the outside capitalist. The danger is apparent, but perception of a danger goes more than halfway towards meeting it. From the political and administrative aspect, agricultural development is one of the surest methods of introducing law and order into a primitive country, and an inflow of capital devoted to this purpose is one of the surest methods of attaining that pacification rapidly. As was pointed out at the commencement, it should be the business of the administration, while doing all it can to attract capital, to see that the dangers accompanying such an inflow are avoided and, more especially, that the foundations of the indigenous social organization are not sapped.

The issue here raised is an important one, and should be clearly recognized; it will be well, therefore, to expand what has been already said on the subject. Availability of external capital is ultimately an expression of the world's needs for that produce which the country is in a position to provide, but which will not be forthcoming if the internal impetus to production is alone relied on. It is, therefore, an issue between the world's needs and the local rights. I would advance the view that it is no longer possible to admit the right of any community to the unquestioned possession of a portion of the world's surface merely on the ground of occupancy. Such a right carries with it a complementary duty, that of the development of local resources; what the economic doctrine recognizes with regard to the individual applies with equal force to the community. While, therefore, occupancy gives an *a priori* claim to possession, there may be occasions when that claim has to be over-ruled in the interests of the world at large. The position here is in some respects similar to that referred to above when discussing the introduction of an economic rent. It was then pointed out that none but an iconoclastic Government would sequestrate, without compensation, rights legitimately acquired. In that case it was also pointed out that the cost of compensation would annul the value of a change. Those rights, however, in a country such as England, have been acquired with a definite knowledge of the potential incremental value and with an eye thereto. Here this is not the case, and the possessor has no appreciation of any incremental value; compensation, therefore, will be comparatively light and may, in certain cases, be justifiable. This it is for the administration to decide—to decide, that is, between the claims of the indigenous population and the needs of the world at large and, if the decision is in favour of the latter, to settle the extent and form of the compensation to be offered. It is one of those cases, earlier adumbrated, where the immediate adjustment between population and production can only be attained by means definitely antagonistic to the line of evolution.

This aspect need, however, delay us no longer. In what follows I assume that an indigenous organization is ultimately to take over the responsibility, and external capital merely employed to expedite, and to supplement the means of, development. Clearly the primary consideration is the direction in which such capital is to be applied. As I have indicated earlier in this discussion, capital serves two functions, the broad distinction between which is, that one falls appropriately within the range of the individual, whilst the other, owing to the area influenced, falls within the range of the State. This is a distinction that must be kept in view if errors are to be avoided and difficulties not to be raised for the future to solve. In the case of every proposal for the application of external capital, therefore, the question should be asked: Is the object to which this capital is to be applied the legitimate function of the community, as represented by the controlling authority, or of the individual? In the former case the settlement of the conditions of employment is a relatively simple matter. The development is, in the first instance, a matter for the State, which can proceed in various ways, by an appeal to the money market for a loan, by a system of agency, or by the grant of concessions. Which method will be the best to adopt will depend on the particular scheme and on the particular views held as to the relative efficiency of direct State, or private, enterprise. In the latter case care will have to be exercised to prevent undue interference with the landed rights of the indigenous population. Freehold grants of land to external capitalistic bodies for extensive farming, however attractive in the first instance, are to be deprecated. However harmless it may appear at the time, such a grant is the first step to expropriation of the people and to the establishment of wage slavery in agriculture. Grants of land, if so given, should be on terms strictly limited, the grantees merely exercising the function of landlords as described above over the land concerned. The units within the grant should be of a size reasonably suited to individual tenure, and mergence should not be permitted.

Among the functions of the " landlord " as defined above I have placed the marketing of excess produce. This is admittedly an ambitious programme. I have placed marketing in that category for simplicity of exposition, for the earlier stages of that process are undoubtedly within his province. Clearly, however, contact is ultimately with the merchant and shipper, the agent who both exports and imports, and thus adjusts the trade balance. Again, it becomes a question of drawing a line between two agencies, and it is possible to draw this line nearer to, or further from, the source of production. It is this ill-defined border-line between the function of the " landlord " and of the merchant that appears to offer the most profitable field for the employment of external capital during the early stages of development. It should not be a matter of insuperable difficulty to extend the merchant's function to include temporarily that of the " landlord " by the grant of a concession which would remain attractive while strictly limiting the period and allowing for the automatic reversion of the " landlords' " rights as and when such a class arises. From this point of view it is merely shifting temporarily the border-line between " landlord " and merchant towards the source of production.

Development, therefore, may frequently best be effected by a body intermediate in character and somewhat difficult to classify, a body which will be complex with respect to the functions it fulfils. Especially is this likely to be the case where that body is established for the promotion of cotton-growing. In many of the areas cotton-growing on a systematic basis is new, and methods have to be inculcated. This educative function, as well as the control and organization of a seed supply, are primarily the function of the State. The provision of the means of cultivation, the clearance of the land, and the bulking of the produce of individual growers are as clearly within the province of the "landlord." Yet all these may conveniently, in the first instance, be aggregated in the hands of concessionaires. A clear recognition of these functions, an equally clear separation of those appertaining to the State, from those appertaining to the "landlord," and of these, again, from those of the merchant, and a definite limitation of power in the case of those of the second class, will be necessary if progress from within is not to receive a check.

Lastly, there is one point which, though bearing indirectly only on the question of land tenure, is so pertinent and, if left unrecognized, might so easily wreck any scheme of development, that a reference must be made to it here. "The danger of going too fast with native races is even more likely to lead to disappointment, if not to disaster, than the danger of not going fast enough." Any extensive development of cotton-growing, if carried out on the above principles of partition of the value of the crop, will at present prices result in pouring money into the country, and its distribution among a class of growers without experience of the possession of excessive wealth. Ignorant of the means of saving or of the application of wealth to development, they will be a prey to every adventurous and unscrupulous trader, and the wealth that might have been used to such advantage will be dissipated without benefit to the people or country. Undoubtedly, if our proposals are to mature, these primitive peoples require to be protected from "going too fast" until such time as a "landlord" class arises which is capable of using these profits with advantage. The need of the State for funds pending the establishment of an economic rent has also been indicated, and these profits form a convenient source especially for the furtherance of profitable schemes of development. We have, therefore, to devise a scheme for directing these temporary profits into the hands of the State for application to such schemes. The simplest method of so doing would appear to be by the adoption of a sliding scale covering all prices of cotton. This scale would be so adjusted that at the lowest reasonable price the cultivator would receive sufficient to attract him to the cultivation of the crop, and the capitalist the expectation of a reasonable return on his investment for the risks involved. The profits from the receipt of any additional price will be divided in such a way that an appeal will be made to the very human instinct both of the cultivator and the investor for profit, but the share paid to each will not rise in full proportion to the rise of price. The exact terms of such a sliding scale are not a matter for discussion here. The principles have been laid down, and, if followed, will result in the diversion of a considerable portion of the profits arising from abnormal prices into the coffers of the State and in the speeding up of schemes of development without the ill effects that might otherwise arise, and without affecting the progress of material and moral development of the races affected.

SUMMARY.

I may summarize the conclusions to which these thoughts have led us. The trend of development in the tropical areas of Africa, and especially those that offer prospects of cotton growing, will be determined largely by the policy adopted with regard to the land, the foundations of which are laid at a very early stage. In these tracts land now possesses little or no value, but will, in the near future, inevitably develop a value; the adoption of a land policy having an economic basis is, therefore, relatively simple, besides being, on theoretical grounds, desirable, more especially as such a policy is in general accord with native custom and appears best suited to achieve progressive material and moral development. The administrative requirements of such a policy, if it is to be applied to the individual holding, are, however, considerable, and on these grounds there arises a need for an intermediate or "landlord" class. Further, the establishment of such a class is likely to be the means of building up, and organizing, the capital requirements of this development.

Such an internal development must be slow in view of a general paucity of population and initial lack of capital. It will, in all probability, be too slow to meet the world's requirements for raw materials. Immediate development, consequently, will take place through the medium of external capital, which should be divorced from the Administration in respect of that portion which is applied to increasing the intrinsic value of the land. It is, however, the function of the Administration to determine the conditions under which such capital is admitted so that the slower development may proceed unchecked; and it should be possible to determine those conditions without undue restriction of capitalistic enterprise.

The economic problem raised in the above article is dealt with in some detail, as well as historically, in James Dundas White's "Land

Value Policy"; the book is, however, addressed to the aspect of the problem as it appears in England. The whole question as it applies to Central Africa is discussed in much detail in Sir F. D. Lugard's "Dual Mandate." The Indian landed system is described in Sir John Strachey's "India: Its Administration and Progress." I have also dealt with the question in its Indian aspect in a simple manner in my "Foundations of Indian Agriculture."

COTTON GROWING WITHIN THE BRITISH EMPIRE—II

BY

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THE ANGLO-EGYPTIAN SUDAN.

THE fact that, so far as long-staple cotton is concerned, the Sudan possesses possibilities of a bigger output than any other part of the Empire, and the important developments bearing directly on cotton production that have taken place in the country during the past few years justify the devotion of rather more space to the Sudan in this paper than would perhaps be warranted by its present production.

In order of importance, the first cotton-growing project to be described is the Gezireh Plain, which lies between the Blue Nile and the White Nile some 150 miles south of Khartoum. The whole area comprises about 3 million acres suitable for cotton, and has a slight fall from east to west, making it a comparatively easy proposition as regards both irrigation and drainage. The main operation is the building of the dam, over two miles long, on the Blue Nile to hold up the water. This will give a storage capacity of about 500,000 million gallons. Owing to various difficulties, mainly financial, the work which was started in 1919 was practically suspended early in 1922. Happily these difficulties were successfully overcome, and in June of that year the Foreign Secretary was able to assure a deputation representative of the whole British cotton industry that the project would be completed. The dam will, however, only be used at present for the development of 300,000 acres, of which one-third will be under cotton each year. Egypt is extremely nervous as to her water-supply, and the Sudan Government has, accordingly, consented to this arrangement whereby the water to be stored by means of the dam at Makwar shall be limited to enough for the irrigation of the present area. Probably this restriction would be withdrawn, however, if compensation water could be provided for Egypt by the construction of a dam on the White Nile. Besides the dam itself there are some 850 miles of canals to be constructed; the work of canalization has made good progress, and it is anticipated that water for 100,000 acres of land under cotton will be available by July, 1925. Meanwhile, four pumping stations are at work irrigating some 20,000 acres of cotton land, all within the area of 300,000 acres already described. The actual growing of the cotton is in the hands of native tenants, while the ploughing, seed distribution, minor canalization, ginning and marketing are carried out by the Sudan Plantations Syndicate. The three-cornered partnership arrangement whereby the proceeds of the crop are divided between the tenants, the Government, and the Syndicate was described by Mr. Thomas in his paper read at the Stockholm meeting of the International Cotton Congress. The type of cotton grown is the Egyptian Sakellarides, which experiment has shown to be the most profitable for the Gezireh.

The completion of the Gezireh irrigation scheme will open a new era in the economic history of the Sudan. Conditions in the Gezireh will be entirely altered when the country ceases to be dependent on the small and unreliable rainfall, and the production in large quantities of a valuable crop such as cotton will bring a degree of prosperity hitherto absolutely unknown.

Another important project is the development of the Kassala area, where cotton is grown in the delta of the River Gash. The Gash, which rises in the foothills of Abyssinia, drains a long, narrow area of mountainous country with a heavy but spasmodic rainfall. Its flow in consequence varies considerably. The flood reaches Kassala during the first ten days of July, and its duration may be taken as seventy-five days. Just north of Kassala it begins to spill over the delta. This delta is extremely fertile, and a certain amount of Sakellarides cotton has been grown there for several years. No means are at present available for storing the water, so after it has soaked into the soil the cotton is sown and there is no rain after October. The limiting factor was lack of transport, all the cotton having to be carried on camels to Suakim, a distance of 250 miles, at a cost of 1d. to 1¼d. per lb. of lint. Moreover, the time of transit was interminable, and during the rainy season transport by camel was extremely difficult. The Empire Cotton Growing Corporation and the British Cotton Growing Association have pointed out the possibilities of this area if a railway were built, and last year the Imperial Government gave the necessary impetus by guaranteeing the railway up to 1½ million pounds. This railway has now been constructed from Kassala to Thamiam, a station on the Port Sudan—Atbara line, a distance of 217 miles, and it is expected that the line will be in working order in time for the crop harvested in 1925. Within ten years of the completion of the railway it is anticipated that 100,000 acres in the Kassala area can be placed under cotton. This will mean a substantial addition to the Sudan crop—possibly as much as 100,000 bales—though the yield from this district, where there are no expensive irrigation works, must vary with the Gash flood.

To the south of the Kassala Province lie the districts of Gedaref and Mefaza, where the rainfall is over 25 inches and where it has been shown that American cotton can be grown. Ultimately it is hoped that the railway will be extended through these two places from Kassala, joining the present line at Senaar and thus forming a new and valuable link in the economic development of the Eastern Sudan.

At Tokar, in the Red Sea Province, there is another valuable cotton area. Here Sakel cotton of excellent quality has been grown during the last few years. The conditions at Tokar somewhat resemble those at Kassala, inasmuch as the cultivated land is the delta of a river—the Baraka. The area irrigated varies, but may be as much as 160,000 acres. Some control of the water is necessary, however, if large areas are to be placed under cotton. The largest quantity produced here up to the present was 18,000 bales of 400 lbs. in 1920-21. The cotton is conveyed by a light railway over the twenty miles to Trinkitat on the Red Sea.

A certain amount of American cotton is also grown in the Sudan. In the Blue Nile Province alone the crop in 1922-23 grown by the Sudan Plantations Syndicate was estimated at about 1,500 kantars, or nearly 400 bales of 400 lbs. each. A beginning has also been made in the Kordofan Province, and the Shilluk tribe on the Upper Nile are beginning to realize that cotton-growing might have certain advantages in providing them with a means of buying their cattle or wives instead of raiding for them.

Almost the only adverse factor in the Sudan has been the prevalence of two pests—in particular thrips and aphis—which have done considerable damage. In the beginning of this year the Sudan Government, with financial assistance from the Empire Cotton Growing Corporation and the Sudan Plantations Syndicate, engaged the services of Sir John Russell and Dr. Martin Leake to report on the lines upon which agricultural research in the Sudan should be conducted. It is hoped that from their recommendations a comprehensive programme of research will be framed, as a result of which measures may be adopted to prevent deterioration of the soil, a more economic system of crop rotation may be worked out, the methods of cultivation improved, and means devised for controlling pests.

An estimate has been made that within fifteen years from the opening of the Blue Nile irrigation scheme the Sudan may be expected to produce a million bales of cotton.

UGANDA.

The systematic cultivation of cotton in Uganda is entirely of recent origin. The crop is grown under rainfall conditions, and the cultivation is wholly in the hands of the native population, which numbers about 3,000,000. Since the setback caused by the war the progress has been remarkable. In 1914 production exceeded that of any previous year and amounted to 42,000 bales, whereas the crop harvested in 1923 reached a total of approximately 90,000 bales, while estimates for this season put it as high as 120,000 bales. The local Government is fully alive to the fact that cotton-growing is the vital interest of Uganda, and that the prosperity of the country rests largely on the development of the industry and the maintenance and improvement of the quality of the crop. The general organization is in the hands of the Government, who, through European officers and native instructors, teach the natives how to grow and handle the crop. Government seed farms have been formed where, by careful selection work, seed of good quality is raised and distributed to the native cultivators. The cotton is of high quality and is used against staple American as well as Upper Egyptian for counts ranging from 30's to 46's twist and 42's to 64's weft. As regards the commercial side of the industry, a comparatively large number of European and Indian firms compete in the purchase of the crop, and this maintenance of competition has in normal times proved ample to ensure an adequate price being paid to the grower; there has consequently been no need to introduce any system of a guaranteed minimum price as in some other African Protectorates. The Government consider that new areas can be planted with cotton if they are opened up in the first instance by the Agricultural Department by means of mechanical cultivation. To assist in this direction the Empire Cotton Growing Corporation presented to the Uganda Government two motor ploughs and tractors, which have been used with satisfactory results in placing new land under cultivation. Last year the Corporation provided about 100 ox-drawn ploughs, which the Government lent or hired to native cultivators to enable them to extend the area of the land under cotton. These have proved so valuable both in the Government ploughing schools and in the establishment of communal ploughing schemes among the natives that the Corporation have this year, at the urgent request of the Governor, supplied a further 300. The success which has attended the establishment of the cotton-growing industry in Uganda undoubtedly owes much to the interest and enthusiasm of the Government, and in particular to the judgment and foresight displayed by the Director of Agriculture.

The Uganda Government have asked the Corporation to supply them with the services of some additional agriculturists. The Corporation are fully alive to the desirability of strengthening the Agricultural Departments of the cotton-growing countries of the Empire, and are convinced that the provision of a sufficient number of efficient agriculturists is one of the chief factors in increasing production. They have accordingly placed at the disposal of the Government four agriculturists who have been the holders of post-graduate studentships under the system inaugurated by the Corporation. Arrangements have been made whereby these officers will be absorbed into the Agricultural Department as and when vacancies occur.

Future development of cotton-growing in Uganda is largely a transport problem. The extension of the industry is limited at the moment by the capacity of the present cumbrous means of transport to the port of Kilindini in Kenya Colony. Ginners in the Busoga area, for example, must now first load the cotton on to the railway to Jinja; there it is transferred to a steamer, or to lighters in tow of a tug, and conveyed to Kisumu, the terminus of the Uganda Railway on the east shore of Lake Victoria. Finally it is unloaded and placed on the train and sent down the railway to the port.

The recent decision of the Imperial Government to assist in the laying of a new line which will connect the Busoga Railway directly with Nakuru, a station on the main line of the Uganda Railway, is a welcome indication of their belief in the prosperity which the extension of cotton-growing will bring to Uganda. The new line will give the Eastern Province of Uganda (which produces the greater part of its cotton) direct access to the coast. It will also pass through the closely populated area of North Kavirondo, where production is steadily increasing, and it will set free for the actual growing of cotton numbers of natives who are at present employed as carriers. A northward branch from Tororo through Mbale to Kumi, and another branch southward into North Kavirondo are included in the scheme. The Governor has expressed the greatest confidence in the possibilities of increased cotton production on the completion of the new railway.

In connection with this scheme the main Uganda Railway will be relaid with a heavier track, to enable it to cope with the increased traffic, and some branch lines will be constructed in Kenya. The total amount required for these schemes is £8,000,000, which is far beyond the present capacities of Kenya and Uganda. The Imperial Government have accordingly announced that, in view of the importance of increasing the Empire's production of cotton, a loan of £3,500,000 will be granted free of interest for five years. The balance will be raised later by a public loan. The decision to construct this railway to connect Uganda directly with the sea is especially gratifying to the Corporation, who had emphasized to the Government the importance of this development.

Another instance may be mentioned of the desire of the local Government to leave no stone unturned in their efforts to do their utmost for the benefit of the industry. Experiments have recently been carried out with a system of road-rail transport to replace motor-lorries. A line has been laid down over a distance of twenty-four miles, and careful records have been kept of the capital and running costs. From the reports received it would appear that for certain classes of traffic the basic idea is sound, but that the estimate is only likely to be economically practicable on a route offering a considerable volume of traffic all the year round, and where no railway is likely to be built subsequently.

KENYA COLONY.

Very little cotton has so far been produced in the Colony. Except in the valley of the Juba River much of the fertile country lies at too high an elevation to be suitable for cotton, and the total exports have never exceeded 1,200 bales in any year. Cotton is now being taken up, however, by the Kavirondo, who live on the east shore of Lake Victoria. The population of the Kavirondo district is large and fairly industrious, while the soil and climate appear suitable. About 10,000 acres were planted last season, though it is reported that some of the chiefs, in their eagerness to assist the Government, have planted with cotton land which they have been told repeatedly is not suitable. However, they were given the seed in the hope that they may combine equal enthusiasm with greater discretion next year. The Kavirondo crop is expected to cover 40,000 acres in 1924. Seven ginneries have either been erected or are about to be built in the country. The chief problem is the training of a sufficient number of native instructors and the provision of adequate supervision by the Agricultural Department's limited staff. The Corporation have addressed an enquiry to the Governor as to whether he is able to make any suggestions as to the directions in which he would welcome assistance from them.

The extension of the Uasin Gishu Railway (referred to under Uganda) will not only give Uganda direct railway communication with the sea, but will also be a valuable factor in the development of the North Kavirondo district of Kenya, the chief export crop from which should be cotton.

TANGANYIKA TERRITORY (MANDATED).

This country, which has an area of some 350,000 square miles and population of about 4,000,000, is well suited in many parts, both in soil and climate, to cotton cultivation. By 1913, after just over ten years' work, the country repaid the considerable pains and energy that had been expended on the industry by the Germans to the extent of exporting a crop of 6 million lbs. Up to this date cotton had been grown both on German-owned plantations and as a native crop, and experience had shown that the most suitable districts were those of Mwanza, Morogoro, Rufiji, and Lindi; several experiment farms had been established, and tests made with seed of various kinds. At first, attention was directed largely to Egyptian types, but the yield from Upland varieties proved in general to be higher, and the country appears to be suited rather to the production of medium staple cotton than of Egyptian.

In the paper presented at the Stockholm meeting it was stated that Major Horne had reported on behalf of the Corporation on the prospects of the Territory for cotton production. After consultation with the Governor, the Corporation offered the services of a senior Cotton Specialist; the offer was accepted, and the specialist, who was seconded from the Indian Agricultural Service, arrived in Tanganyika accompanied by an assistant in July, 1922. At the request of the Director of Agriculture he proceeded at once to Mpanganya, on the Rufiji River, which had been the most important German cotton experimental station. There, and subsequently at Morogoro on the Central Railway, he has carried out selection work and varietal tests. Spinning tests have been carried out on samples sent home, and from a consideration of the results of these tests and of the agricultural characteristics of the selected plants it is hoped to develop varieties specially adapted to the two areas mentioned, and ultimately to produce sufficient selected seed for general distribution to the natives in these districts. It is hoped that cotton-growing will thus be established in the Territory on a sound scientific basis.

Apart from this work, however, the Corporation confess to a certain disappointment with the output from Tanganyika. The amount of seed distributed in 1922-23 exceeded by 65 per cent. the amount for the previous season, yet the crop was 2 per cent. smaller, amounting to 7,175 bales of 400 lbs. No doubt adverse weather contributed partly to this result, but the standard of cultivation among the natives is low, and the present resources of the Agricultural Department, both as regards personnel and funds, will probably be severely taxed to develop a system of propaganda through native instructors to teach improved cultural methods. The presence in the Territory of the Corporation's officer, who has had long experience of the crop in India, places at the disposal of the Government expert advice on matters relating to cotton-growing and marketing, of which the Corporation hope that the Agricultural Department will avail themselves freely. As an exceptional matter the Corporation contributed £5,000 to the budget of the Agricultural Department for the year 1923-24 in order that the staff might be enlarged and more cotton work undertaken.

Up to the present by far the greater part of the crop has been produced by native cultivators on their own holdings; the problem, therefore, so far has been mainly one of extending and improving native production. Gradually it may be found possible to introduce the ox-plough in districts not occupied by tsetse-fly, an innovation which has played an important part in raising the output of cotton in Uganda to its present proportions. But primarily the native has still to be persuaded of the advantages to himself of a cash crop such as cotton. At present his wants are few; his ambitions are practically limited to obtaining a sufficiency of food for his use and that of his family, and these can be satisfied with a minimum of inconvenience by setting his womenfolk to cultivate his small-holding. But if he can be induced to see in cotton a source whereby he may not only pay his taxes, but also purchase for himself a few luxuries, he may eventually come to realize, if not the dignity of labour, at all events the material advantages to be derived from it. In a few years his luxuries will have become to him necessities, and the incentive to regular work will have been provided.

The progress of Tanganyika, in common with that of every other African territory administered by Great Britain, is entirely dependent on the provision of transport facilities. It was stated in the first part of this article (July number, page 162) that the construction of a railway from Tabora on the Central Railway to Mwanza on Lake Victoria was under consideration. The Corporation have since learnt with great satisfaction that the expenditure for the construction of the first 80 miles from Tabora northwards as far as Kahama has been sanctioned, as has also the reconditioning of part of the Lindi Light Railway and its extension from its present terminus on the Rovuma River to Lindi Harbour: this light railway is of great immediate value to cotton production in the Lindi district. This provision of increased transport facilities is especially gratifying in view of its extreme importance to the development of the cotton-growing industry in the Territory.

NYASALAND.

In one important respect the problems affecting cotton-growing in Nyasaland differ from those of other British Dependencies in tropical Africa. Eighty per cent. of the crop is grown on plantations owned by Europeans with hired native labour working under white supervision. It is essential, therefore that the Government should be able to command the confidence of the planters and enlist their co-operation in any measures they may wish to take for the improvement of the crop. At the Governor's request the Corporation have appointed an experienced officer as Cotton Specialist, with a small staff of his own, to assist the local Agricultural Department in this branch of their work, and it is gratifying to be able to record that numerous letters from planters have testified to the valuable assistance that they have derived from this officer, and to the improvement in their crop consequent upon following his advice as to methods of cultivation. A cotton experiment station of about 100 acres has been established and placed in the charge of officers appointed by the Corporation. At this station it will be possible to work out some of the numerous problems that await solution, both as to the cultural methods best suited to different parts of the Protectorate and as to improvement in the seed supply.

For the plantations in the Highlands, the production of an early-maturing variety is badly needed, since the cold weather following the rains makes the growing season a short one. The crops seem also to be particularly susceptible to boll rot, which quickly spreads through the fields. In the low-lying parts of the country, cotton-growing for the most part is a native industry, and a considerable extension is hoped for in this direction. It is true that the fact that the rains are apt to begin late means late planting, and the danger of subsequent rains preventing the development of the plants, but the Agricultural Department are devoting considerable attention to improved methods of cultivation under the special climatic conditions, and the Corporation's officer reports that their work is beginning to bear fruit. Another factor that will doubtless have a marked beneficial influence on native production is the contract entered into between the Government and the British Cotton Growing Association with regard to the purchase of the crop for a period of five years. Under this scheme the Association will purchase all cotton grown by natives on Crown lands at a guaranteed price. The net profits will be shared equally between the Government and the Association, and a sinking fund will be created to enable the price to be maintained if the market is low. By thus assuring the grower of the price that he will obtain for his crop, a marked increase in native production may be anticipated, and it is hoped that in the course of the next five years the native crop will be firmly established. As a result of this arrangement the marketing of the crop has also been greatly facilitated. Market centres are now kept open throughout the season on certain days of the week, and buyers appointed by the Association attend to purchase the cotton brought in.

It has been reported that remedial measures against the red boll-worm are urgently required, and the Corporation have provided the services of an entomologist to devote his whole time to cotton pests in the Protectorate and thus relieve the Government entomologist.

Transport problems hold an important place in the development of Nyasaland. An extension of the existing railway northwards to the Lake is under consideration, but much difference of opinion exists as to the route to be followed. The respective merits of the several routes proposed need not be considered here, but it is hoped that a decision will be reached as soon as possible, so as to allow this important work to go forward, and in this connection the possibility of a subsequent extension to North-Eastern Rhodesia will doubtless not be overlooked.

The full development of the Protectorate is necessarily dependent on its being connected by railway with the sea. The opening of the Trans-Zambesi Railway has provided the link between the Zambesi and the port of Beira, but until the river is bridged all exported produce necessarily incurs the delay and risk of damage inherent in the present system of ferrying across the Zambesi, while the necessity for handling and breaking bulk adds to the cost of transport.

The output of cotton is increasing satisfactorily, and the estimate of 6,500 bales for this season's crop, made last November, is an increase of 1,000 bales on last year, and nearly double the crop of 1921.

NORTHERN RHODESIA.

From April 1, 1924, Northern Rhodesia has passed under the direct administrative control of the Colonial Office.

Attempts have been made to grow cotton in two widely separated areas—namely (*a*) on the Livingstone—Broken Hill Railway, and (*b*) in the neighbourhood of Fort Jameson, near the Nyasaland border. With regard to the first of these areas, the Agricultural Department carried out experiments at Mazabuka, about 180 miles by rail to the north-east of Livingstone, during the period of 1908-17. The results obtained were varied, but on the whole unsatisfactory; the conclusions arrived at were that the erratic nature of the rainfall in that neighbourhood rendered cotton a somewhat speculative crop. A few of the settlers have, however, successfully grown small quantities of cotton on their farms, and between 1,500 and 2,000 acres are said to have been planted this season. Two small ginneries and presses are reported to be in process of erection at Pemba, and enquiry has been made of the British Cotton Growing Association with a view to the supply of plant on the hire-purchase system for erection at Mazabuka.

Mr. Sampson, the Corporation's Cotton Specialist in Nyasaland, was able to visit the area round Fort Jameson, much of which is owned by the North Charterland Exploration Company. He came to the conclusion that much of the land is suited for cotton cultivation, but that the possibilities are at present limited by two factors—viz., the presence of the red boll-worm and the lack of cheap transport. The red boll-worm is proving a very serious pest in Nyasaland also, and, as stated in the section dealing with that country, an entomologist has been sent out to that Protectorate by the Corporation in the hope that he may be able to assist in devising some means of controlling the pest. The conditions in the Fort Jameson area are generally similar to those in Nyasaland, and any measures for combating the boll-worm resulting from work done in the latter country should be applicable to the Fort Jameson area.

With regard to transport, the extension of the Nyasaland Railway may lead eventually to the provision for North-Eastern Rhodesia of an outlet to the coast in this direction. The present cost of transport, partly by wagon and partly by motor-lorry, from Fort Jameson to the nearest station on the Nyasaland Railway, works out at a little over 2¼d. per lb. of lint.

NIGERIA.

Indigenous African cotton has been grown in Nigeria for generations, but the development of the export trade dates from the formation of the British Cotton Growing Association in Manchester in 1902. The whole of the cultivation is in the hands of native farmers, and the ginning and marketing of the crop was until recently carried out entirely by the Association, who guaranteed prices for first and second grade cotton to the growers before each planting season began. Close co-operation between the Agricultural Department and the British Cotton Growing Association has brought about a notable change in the character of the cotton exported, especially from the Northern Belt. Cotton of the American type was introduced into this area from Uganda, and its cultivation has been steadily improved and extended. The success which has attended this enterprise is due to the officers of the Agricultural Department, who have been unremitting in their efforts to ensure purity of the seed supply, and to the Association, whose guarantee of an enhanced price for the exotic cotton naturally provided a stimulus to cultivation.

In the Northern Belt over 10,000 bales of American cotton were purchased in 1922-23 and no native cotton; in the Middle Belt the purchases were 479 bales of American and 1,179 bales of native, while in the Southern Belt only 40 bales were American and 4,355 were native. From these figures it will be seen that in the Northern Belt the cultivation of exotic cotton has been firmly established; in the Southern Belt, however, it seems probable that the climate is not favourable to the cultivation of any of the varieties of exotic cotton that have hitherto been tried, and the Agricultural Department are steadily pursuing their experiments with a view to discovering a suitable variety that can profitably be substituted for the indigenous type, which is of considerably lower value to the spinners of Lancashire.

During the past few years the total crop exported each season has been in the neighbourhood of 15,000 to 17,000 bales, except in the season 1920-21, when the enhanced prices that the Association were able to guarantee caused 32,000 bales to be brought to market. But a gratifying feature is that American cotton has formed a steadily increasing proportion of the crop.

The possibilities of the future are believed to be very great. The immediate need is to secure the rapid multiplication of exotic seed in the Northern Belt, and this may entail the provision of extra staff for seed farms and for seed distribution. But once again the chief factor in increased production will probably be found in increased transport facilities. In the Northern Belt considerable areas of potential cotton-producing country could be opened up by building roads to feed the railways, while the fact that at present all the American cotton is collected from about ninety miles of railway suggests greatly increased production if new lines are planned so as to tap the most promising areas. In the meantime the Corporation intend to carry out in Nigeria experiments with certain types of "track" vehicles which do not need metalled roads, to ascertain how far these would assist the transport of cotton in outlying districts.

An acknowledged difficulty is the fact that many of these areas are at present very sparsely populated, and last year the Empire Cotton Growing Corporation submitted for the consideration of the Nigerian Government a scheme for the formation of cotton colonies in suitably selected places. The difficulties of moving a native population are admittedly great, and the local Government ultimately decided that the suggestion was not at present feasible. The initial cost of the scheme would have been borne by the Corporation, but of course a scheme of land settlement must ultimately be self-supporting, and of this prospect the Government had grave doubts. The same result may, however, be obtained when railways and roads are carried through some of the districts in which cotton production holds out the greatest possibilities, and any steps that secured such a redistribution of the population could not fail to benefit all kinds of agriculture, since the land surrounding the old cities, in which the population is now largely concentrated, is becoming less productive through centuries of cultivation.

Another direction in which the Government can assist in the development of the country generally, and of cotton production in particular, is by an enquiry into its possibilities for irrigation. All the cotton grown at present is dependent on suitable rainfall, and short crops are due as a rule chiefly to semi-failure of late or early rains. If suitable projects can be framed for utilizing by means of irrigation the Kaduna River for the benefit of the cotton fields to the south of Zaria, and the River Niger to develop the possibilities of cotton production in the neighbourhood of Yelwa in Kontagora Province, a greatly enhanced export of cotton may be expected from the Protectorate. It was announced early this year that the Government have engaged the services of one of the senior engineers in the Irrigation Department of South Africa to prepare a comprehensive report, and if the result is favourable important developments will be rendered possible. The Agricultural Department is intensely active in all matters that may lead to the prosperity of the natives, and may confidently be relied on to press forward any practical propositions to this end.

SIERRA LEONE.

Attempts were made by the British Cotton Growing Association from 1901-1907 to establish cotton-growing in Sierra Leone, but without success. The Governor is, however, anxious to make a further attempt in other parts of the Protectorate, since it is now considered that the former experiments failed by reason of the site selected for them having been unsuitable climatically. The places now proposed are almost entirely lacking in transport facilities, and, even if the soil and climate prove favourable for the cultivation of cotton of good quality, the success of the venture will be contingent upon either the provision of some form of transport or on the growers being willing to carry their produce a long distance. The best native cotton grown at present, which is extensively used in native manufactures, has a staple of about 1 inch in length, and the ultimate success of the proposed experiments would seem to depend largely, therefore, upon whether an exotic variety, such as Allen's long staple, which is now established in Nigeria, can be introduced in place of the native variety. Seed has been imported from Nigeria with this object, and selection work is also being done with the native cottons in the hope of obtaining a longer staple. Samples of this type recently received from Sierra Leone have been favourably reported on by brokers.

BRITISH WEST INDIES.

These islands are now practically the only source of supply of Sea Island cotton. In spite of this monopoly, however, the industry has been passing through a most critical time during the last few years. Sea Island cotton, on account of its fineness and length of staple, is used for lace-making and for the finest cotton fabrics, and the general depression of trade in Europe has caused demand to be curtailed to a point which does not permit of the consumption of the crop, while prices have necessarily dropped to a level which has caused serious discouragement to the growers. British manufacturers have done their best to help by buying and carrying stocks for two or three years which can only very gradually be put into consumption, but the price has risen slightly this year with the general hardening of the market, and it is hoped that a revival in trade will stimulate consumption sufficiently to reduce the surplus stocks. In order to be prepared for all eventualities, however, the Imperial Department of Agriculture for the West Indies has been considering whether it may not in the future become desirable to introduce other types of cotton into certain of the islands, with a view to breeding long-stapled varieties, which would find a less specialized application than Sea Island, and thus command a wider market, and experimental genetical work is being conducted at the College in Trinidad.

At the end of 1920 the pink boll-worm made its appearance in Barbados, and has since spread to most of the other cotton-growing islands. This pest has naturally reduced the yields and unfortunately added to the difficulties of the growers. The Department of Agriculture has taken all possible means to mitigate the damage, and legislation has been enacted requiring close seasons in all the islands during which no cotton is grown, while seed is subjected to disinfection wherever facilities exist. On the whole, thanks to the steps that have been taken, the damage to the crop in most of the islands, while still severe, has not assumed alarming proportions.

The Corporation recognize fully the importance of preserving the qualities of Sea Island cotton, and for the past four years they have maintained a small experiment station on St. Vincent in the charge of a well-qualified research worker, who has devoted his whole time to the study of problems connected with the genetics of cotton and the production of improved types, so that this variety may retain its unique qualities in readiness for any revival in the demand.

Reference has been made already to the support given to the Imperial College of Tropical Agriculture at Trinidad, and the value which the Corporation attach to the work that it is capable of doing in giving a good grounding to men who intend to carry on agricultural work in any of the tropical parts of the British Empire.

BRITISH GUIANA.

Between the years 1823 and 1828 quite an appreciable quantity of cotton was exported from British Guiana. This cotton was short in staple and was grown on the coast from a perennial type resembling the present-day Brazilian cotton. The disappearance of the industry seems to have been caused by scarcity of labour and the competition of the sugar crop. Trials were conducted by the Agricultural Department during a number of years with cotton of the Sea Island and Egyptian types, which were found to be unsuitable to local conditions, the soil being generally too heavy and the crop damaged by rain during the ripening stage. Types of cotton suited to the country were evolved by crossing Sea Island and Egyptian cottons with the indigenous tree cottons, but scarcity of labour prevented the planters and farmers from taking up this crop. It seems possible that when labour becomes more plentiful in British Guiana cotton-growing may once more become an industry of importance both on the front lands bordering on the coast and on tracts inland where the soil is found to be suitable. It is possible that in the near future arrangements may be made for the immigration of East Indian peasants into Guiana from some of the overcrowded areas in British India.

CEYLON.

A little cotton has been grown in Ceylon for many years, but when prices were low tea and rubber were found to be more profitable. With the incentive provided by the rise in the price of cotton, however, the well-organized and efficient Department of Agriculture have, in the last few seasons, carried out carefully planned experiments on cotton production at Ambalantota in the south-east of the island. These experiments have had as their objects the determination of the relative yields per acre of different varieties, the cost of production and the value of manuring. The varieties selected for peasant cultivation are Cambodia, Durango, and an American Upland type grown from seed supplied from South Africa. A scheme was worked out for encouraging cultivation in one-acre plots, and in 1923 applications were received for seed to plant 1,648 acres. The whole crop has hitherto been sold by the peasants in the first instance to the Government at a guaranteed price, and the total output is absorbed by the Colombo Weaving and Spinning Mills, who have again this season offered to buy the whole crop at Rs. 21 per cwt. of seed cotton for Cambodia and Rs. 25 per cwt. for American Upland. The yield per acre in the experiments conducted by the Agricultural Department was promising, and the quality of the samples that were sent to the Empire Cotton Growing Corporation was satisfactory. Nevertheless, it is doubtful if Ceylon is likely to be able to produce cotton in any very large quantities.

The area of the island which has a climate really well suited to cotton, with practically no risk of unseasonable rain about April, just as the bolls are ripening, is confined to the Manaar district in the north-west, and to a strip along the east and south-east coast, where there is at present no available population, except about Mullaitivu, Trincomali, Batticaloa and Hambantota. Important railway extensions are now under construction linking up both

Trincomali and Batticaloa with the main line, and the Governor is hopeful that the area through which the new lines will run may prove suitable to cotton-growing on an extensive scale. It is to be feared, however, that much of this country, except that which lies immediately behind the coast, will be found to be liable to excessive rainfall in April, and in any case movement of new population into these admittedly malarious districts may be slow. However, at the Governor's request the Corporation are endeavouring to arrange for the loan of the services of a well-qualified expert for the purpose of a short tour in the country, in order that its possibilities may be more fully gauged. The Government are anxious to encourage cotton cultivation in every possible way.

IRAQ (MANDATED).

While the Turks were still in Baghdad the possibilities of Iraq (Mesopotamia) as a cotton-growing country were being investigated. As soon as conditions permitted, experiments were set on foot to determine which variety of cotton was best suited to the climate and the soil, and the subsequent history of cotton cultivation in the country up to the present time is a record of careful scientific work carried out under most adverse and discouraging conditions. Altogether some thirty different varieties have been tested, and nearly every year some unexpected disaster has overtaken at least a part of the experimental crop. One year it was destroyed by locusts; another year by shell fire during the Arab rising; a third year much of the area planted yielded practically no harvest owing to water shortage. However, the Agricultural Department and the British Cotton Growing Association have persevered, and it is most gratifying to know that, as a result of the experiments of the former body and the steady encouragement afforded to the industry by the prices offered by the latter, the 1923 crop amounts to practically 1,000 bales of 400 lbs. The type of cotton from which these thousand bales have originated is a long-stapled American Upland. Since its importation into Iraq, it has shown a modification of some of its original characters, and may now be accurately said to be a separate type. The name of Mesowhite has been given to it. The cotton industry has this great point in its favour in Iraq: only one kind of seed is distributed by the Agricultural Department, so that the cotton that results as the acreage increases should be unmixed and uniform in character. The two chief things that are needed for the development of the industry are political tranquillity and adequate water control. The country has already benefited from the generous policy adopted by the British Cotton Growing Association in maintaining prices when the market was low, and this farsighted action has undoubtedly contributed largely to the successful establishment of the industry.

CYPRUS.

Cotton has been grown for some centuries and is still one of the most important products of the island. The native species is *Gossypium herbaceum,* but this has been largely replaced by *Gossypium barbadense* during the past twenty-five years. The former is grown without irrigation—a method known as " dry " cultivation—and is not exported. Several varieties of American cotton have been grown both " wet " (irrigated) and " dry," and good results have been obtained. About 700 tons of American seed were sown in 1922. For several reasons very little Cyprus cotton has ever been shipped to Great Britain. In the first place, freight rates to England are much heavier than to either Marseilles or Trieste; secondly, Marseilles is prepared to take quite small consignments which do not appeal to Liverpool; and thirdly, the French factories do not make such a feature of uniformity of type. The merchants of Cyprus are scarcely competent to distinguish between the several varieties grown, and the bales usually contain a mixture. Since the war the greater part of the cotton has been shipped to Greece, where it is readily taken up. In Liverpool, Cyprus cotton has recently been valued at about fifty points off middling American.

MALTA.

Cotton is being grown on a small scale, but entirely under rainfall conditions. This being so, the acreage varies according to the storage of moisture in the soil during the rainy season. The varieties grown are chiefly Maltese cotton, which has been grown on the island from very early times, and Levant, or Gallipoli, cotton; both are short-stapled. The production in 1922-23 was 193 bales of 400 lbs. It is, however, actually exported in large bags of variable weight. Its destinations are Great Britain, Italy, Beyrouth, and Greece.

FIJI.

Between the years 1864 and 1884 the annual export of cotton for Fiji exceeded 1,000 bales of 400 lbs. Gradually the acreage under this crop dwindled until it ceased to be grown in 1900. In 1920 attempts were made to revive the industry, and arrangements were made to import a supply of seed from the West Indies. While this seed was in transit, however, an outbreak of pink boll-worm was discovered in the islands from which the seed had been despatched. It was accordingly destroyed before it reached Fiji. In 1922 the presence of pink boll-worm was discovered in Viti Levu. The Planters' Association of Fiji have asked whether it would be possible for Mr. Evans, the Corporation's Cotton Specialist in Queensland, to visit Fiji to advise the planters regarding the possibility of restarting the growing of cotton. The Corporation replied that the Government of Queensland have the first call on Mr. Evans' services, but that, should they be willing to allow him to visit Fiji and consider that such a visit could be made without detriment to his work in Queensland, the Corporation would be willing to discuss arrangements with the Government of Fiji. As the outcome, Mr. Evans visited Fiji in June of this year, but his report had not been received at the moment of going to press.

PAPUA.

Small quantities of Sea Island cotton have been grown in the past in this island, but little progress was made, and the Company that undertook the experiment were not allowed to employ casual labour for picking. In 1921 the newly appointed Instructor of Native Plantations wrote to the Empire Cotton Growing Committee of the Board of Trade stating that he had had experience of cotton in the American Cotton Belt, and asking whether the Committee would be prepared to provide ginning machinery and to subsidize the industry for the first few years. He stated that it had been proved that cotton would grow, and that he had arranged with the Queensland Government that he should be provided with seed. The Committee obtained for him at his request a small quantity of selected Sea Island seed from Barbados, and in their reply stated that the Corporation had still to be established. Reports have been asked for regarding the experiments which it was proposed to carry out, but so far these have not been received. Until experiments have been undertaken in Papua to ascertain whether or not cotton can be grown there on a commercial basis, and until brokers' reports and spinning tests have been obtained regarding the quality of the lint produced, it is impossible to say whether this country is capable of adding its quota to the world's supply of cotton.

The foregoing summary gives a brief account of the steps that have been taken and the progress that has been made towards the development of cotton-growing in the principal Dominions and

Dependencies of the British Empire, in which the industry has so far been established, or in which experiments have led to promising results. The Empire Cotton Growing Corporation fully recognize, however, that the present shortage of the world's supplies of raw cotton requires for its early alleviation the wholehearted co-operation of all countries in whose territories the extension of cotton cultivation can be successfully attempted. It is hoped, therefore, that all such countries will do their utmost with a view to rendering effective the resolution adopted by the Committee of the International Federation of Master Cotton Spinners' and Manufacturers' Associations at its meeting in London on October 12, 1923:—

> "The Committee of the International Federation of Master Cotton Spinners' and Manufacturers' Associations, realizing more than ever the imperative need for an immediate increase in the supply of raw cotton, urges upon all Governments whose lands have been found capable of growing cotton to stimulate the development of cotton cultivation on a commercial scale."

FIG. 1.—WAITING FOR LANCASHIRE TO DELIVER THE CLOTH.

FIG. 2.—A B.C.G.A. BUNGALOW IN UGANDA

Fig. 3 Handling Seed Cotton.

Fig. 4.—Namasagali—Transferring Cotton from Lake Steamer to Rail.

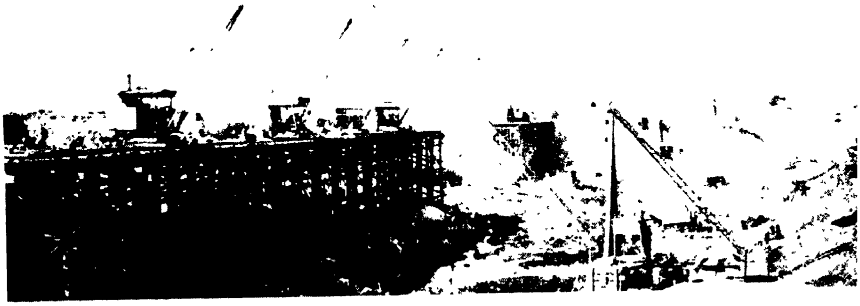

Fig. 5.—The Senaar Dam.

A TRIP THROUGH UGANDA AND THE SUDAN

BY

E. AND A. M. PORRITT.

We are asked to contribute to this magazine an article on our journeyings of last winter, but the impressions and memories that they have left with us fill us with a hopeless sense of its inadequacy.

To attempt a description of striving, gallant Kenya, building its road to civilization through jungle and unknown wilderness; to paint a word-picture for you to see Uganda in all its green loveliness, with its great lakes strewn with water-lilies of many colours and its winding tawny-red paths; to lead you by the long stretches of the Nile, through the vast open spaces of the Sudan, would need a more experienced pen than ours. We can but give you a little account of our journey to these wonderful places in the hope that it may commend itself to a few who have already interests in distant Africa.

We sailed from Tilbury by the Union-Castle Line on December 5, and our first stop at Port Said, the gateway to the East, filled us with the glamour of colour and life, new faces and new races, and we watched with amazement the natives diving for coins thrown by the passengers, their bodies gleaming like copper in the sunshine.

We had a very pleasant journey through the Red Sea, by no means overwhelmed with heat, as some of the pessimists at home had prophesied, but able to take part in deck sports and games; we found it a pleasant change to spend Christmas Day clad in summer clothes and enjoying iced drinks !

Our second stop was at Port Sudan. Being a modern port it has the advantage of modern appliances in the shape of electric cranes, etc., and with its deep-water quays is destined to be a great port of the future. The sheds and quays were filled with material for the new Kassala Railway—then making rapid progress towards completion—and cotton from Khartoum and Tokar awaiting shipment by the next homeward-bound steamer.

We called at Aden, at which place the mails from India for Africa are collected, and whilst waiting for these we had time to be rowed ashore and get a glimpse of the Asiatic. It is an exceptionally dry place, and the chief point of interest for visitors are some ancient tanks, away up in the rocks, wonderfully formed in order that the scant rainfall may be utilized to the very best advantage.

On December 28 we dropped anchor in Kilindini Harbour, which is the port for Mombasa, the commercial centre of Kenya Colony. The approach is unexpectedly beautiful, as the steamer has to be piloted between many green islands, luxurious with tropical vegetation and palms. We were conveyed from the steamer to the landing-stage by motor-launch, and then driven up to the town, some little distance away, along a beautiful road through avenues of fruit trees and gaily flowering shrubs. The town of Mombasa contains several hotels, good clubs, some beautiful quaint old streets with old carved doorways and Moorish arches that reminded us of Algeria, and a large native quarter where the dwellings are of mud with picturesque overhanging roofs of rush. The rest of the island appeared to be laid out with bungalows for the white population, which is growing rapidly, and golf links and tennis courts for their recreation. The Uganda Railway starts from Mombasa, and for the whole of its nearly 600 miles to Lake Victoria Nyanza it is a wonderful triumph of engineering. It rises nearly 8,000 feet, and falls again to 3,750 feet at the present terminus, Kisumu, on the great lake.

We had a wonderfully interesting journey up the line to Nairobi. We started in the afternoon and spent one night in the train, and awoke to find ourselves in the game reserve, where whole herds of buck, buffalo, antelope, gazelle and hartebeest, a few ostriches and a solitary giraffe, were grazing within sight of the railway line. We were not fortunate enough to see any lions, though we were told that they are sometimes to be seen there at dawn. We passed through Tsavo and Simba, where lions were so troublesome during the construction of the railway.

Nairobi, where we arrived about noon, is the seat of the Government, and has, with the surrounding highlands, a delightful climate suitable for British colonists. The snow-clad summits of Mount Kenya and Kilimanjaro are both visible on a clear day. Generally speaking, Kenya Colony is not suitable for cotton-growing, but the head of the Agricultural Department informed us that experiments were still being made in various of the lower-lying districts in the hope of opening out new cotton-growing areas. Subtropical crops, such as coffee, sisal hemp, etc., had had a good season. Everyone was hospitable and kind to us, and Government House did everything to make our progress through Uganda to the Sudan run smoothly, so that we were sorry, when the time came to take the train onwards, to leave this happy circle of colonists.

The journey from Nairobi to Lake Victoria and Uganda was most interesting. At the different stations crowds of natives had gathered to see the arrival of the train. There are many different tribes, and each has its own fashion and design for dress—or the lack of it (Fig. 1). Hair-dressing is a fine art. The head is shaved, leaving little patches of hair in different designs according to the tribe, and beads of all shapes and sizes are worn in modes both elaborate and crude. We spent one night in the train, and arrived at Kisumu, the port on Lake Victoria, at noon on the next day. Here we boarded the *Clement Hill*, and had a most wonderfully calm and beautiful trip across the immense Lake Victoria Nyanza. There were quite a number of interesting passengers on board the little steamer, including an author, several big game hunters, and settlers of all descriptions. We were consequently well entertained, and heard some hair-raising shooting stories. The boat first called at Entebbe, the administrative centre of Uganda, at about noon on the next day, and then went on to Port Bell, which is a little further north, where we went ashore. This is the port for Kampala, and we were met on the quay and taken there, about six miles distance, by car.

Kampala is the native capital of Uganda and the residence of the King and his ministers. It is the headquarters of various missions, and has two magnificent cathedrals built almost entirely by native effort. The missions educate, and teach various handicrafts in co-operation with the Government, and it was interesting to see the first cotton ginnery erected in this part of Africa by the Uganda Company, Ltd., started originally to carry on the commercial side of the mission stations' work. Kampala is beautifully laid out, and growing rapidly. There are about 500 white settlers who live mostly in pretty bungalows, and they have a good hotel, club, golf course, etc. The high price of cotton was helping the flow of money, and the Indian bazaar had never been so full of goods, anticipating the increased buying power of the natives. The natives here are more civilized, and dress better than in any other part of Central Africa, and appreciate the finer descriptions of cotton goods produced in Lancashire, but we were informed in the stores that, apart from the local demand, the native prefers the grey cloth made in America or Japan. With so much unemployment at home, it seems a pity that such a large proportion of the goods sold in Kenya and Uganda are not made in England. The natives walked with a very graceful carriage, a result no doubt produced by the custom of carrying everything on the head. They carry out this practice to an amusing extreme, never thinking of taking a bottle of medicine or a box of matches home in the hands, but perched on the top of the head, and we even heard of one poor man who was asked to take a bicycle home for his master, a distance of about eight miles, and who, although the road was quite good, arrived with it on his head!

One day we motored over to Entebbe, a distance of twenty-five miles by the road, which is an excellent one, and provides some glorious views of the lake. Entebbe itself is a little paradise—full of trees and flowers and singing birds. It is laid out like a beautiful park, with charming bungalows for the Government officials, of whom practically the entire white population consists.

When we left Kampala we went down to Port Bell again and once more boarded the *Clement Hill*, but this time only for a few hours, as we had arranged to stay at Jinja, which is situated a little higher up the lake. We had a delightful week there, through the kind hospitality of the representative of the British Cotton Growing Association and his wife, at their pretty bungalow in a beautiful position above the lake and the Ripon Falls (Fig. 2). Jinja is a charming little place, with a nine-hole golf course and tennis club, and the white population, though few in numbers, most kind and hospitable. Hippopotami and crocodiles are common sights here; one hippo that is sometimes seen strolling across the golf-links and up and down the roads has been christened "Herbert," and is quite a popular fellow. The crocodiles are hated by everyone, as they are known to nip off with the black boys whenever opportunity offers. We used to go down to the Ripon Falls, where the Nile commences its 3,000 miles course to the sea, and watch them sleeping on the rocks that appear above the water.

While in Jinja we collected servants, stores—and much advice—for our "safari," or trek, which is necessary in order to reach the Sudan from Uganda. Everything had to be packed in cases not exceeding 60 pounds in weight, as it all had to be carried on the heads of native porters for a distance of ninety-six miles, and when we left Jinja our luggage was in a wonderful collection of packages, including a tin bath full of pots and pans, wooden cases of tinned food, and sacks of rice—to say nothing of our beds, tables and chairs, and our ordinary cases of clothing. At Jinja we had collected a cook boy, personal boy, and head boy, and the latter took on the responsibility of the luggage, etc. We then journeyed by rail to Namasagali, where we found the steamer for Lake Kioga awaiting us.

We spent three days on this lake, the little steamer *Stanley* pushing barges ahead of her through masses of water-lilies and papyrus, and picking up bales of cotton, etc., at various calling-places (Fig. 3). The cotton is grown by the natives in their own gardens or fields, picked, and carried on the head for sometimes great distances to the nearest "buying-post." Here, on account of competition, the native gets a good price, the buyers for Japan being often able to pay more than the British buyers, probably on account of the cost of production at their mills being so much below ours. The cotton is packed into bags of about 100 pounds, weighed, and sent by road to the nearest ginnery, where the seed is separated from the lint. It is then baled and pressed, and sent to the steamer. When delivered at Namasagali it is transferred to the train for Jinja (Fig. 4). From Jinja it goes by steamer to Kisumu, and again by rail to Mombasa. All this handling adds greatly to the cost of the cotton, and there will be great rejoicing when the new projected railways are completed and there is direct communication between the cotton fields and the coast.

We landed at Masindi Port and were taken on a motor-van to Masindi, where we were put up by the kindness of the District Commissioner, as the little hotel was not open, and there was not a boat for us to cross Lake Albert for a day or two. The day before the boat sailed from Butiaba we were motored there, and went on board the tiny steamer *Livingstone*, which sailed at 5 a.m. next morning. We spent two nights on board. It was fortunately calm, and we were the only passengers, which was lucky, as there was only one small cabin. We slept on deck, and used the cabin for meals.

At Nimule we landed with all our goods and chattels, and said good-bye to civilization for a week, sleeping in mud huts and marching on in the early mornings, always aiming at reaching our next rest-hut before ten o'clock, by which time the sun became too hot for walking. We were allotted a fully armed policeman and thirty stalwart porters at Nimule, who carried everything of ours, and a certain amount of paraphernalia for our boys, who proved themselves very good fellows. The cook would barter for eggs, chickens, or guinea-fowl wherever they were procurable, and managed to do up the chickens in various forms of disguise. They are funny little creatures, and one would get very tired of them if they were not well cooked. The head boy was extremely useful in organizing the packing and unpacking at each camp, and kept the porters going, distributing the weights as fairly as possible. We found them willing workers, and seldom heard any grumbling, though on some occasions a man would carry 60 pounds for twenty miles. They liked to get the work done before the heat came, and then rest all day. During the march, half-an-hour's rest occasionally and a cigarette seemed to quite satisfy them. The cigarettes were greatly prized, and had to be given out somewhat sparingly, as we had not a very large supply and, of course, could not buy more *en route*. The men seemed to appreciate this, and were often seen to carefully cut them in half and put one half away for the next halt. Half-way on the journey we had to take on a new relay of thirty porters as a precaution against their carrying sleeping-sickness from one province to another.

We arrived at Rejaf early one morning, and there rejoined the Nile. This marked the end of our walk, as the little steamer was due that day and would take us on its return journey to Khartoum. We met with no wild beasts or great adventures on the "safari," but quite often heard sounds of grazing in the darkness before dawn, and weird noises of elephants in the vicinity. We never saw any of the latter, but on one occasion saw their large footprints on our sandy pathway, and the boys told us they were not far away. We came across a few antelope and monkeys, but a lion that was said to have taken a few natives at one village kept out of our way. Mosquitoes and tsetse fly paid us a little attention, but with regular doses of quinine we suffered no serious effects.

At Rejaf we parted with the boys and porters, and became more civilized again. The steamer took about ten days to reach Khartoum, 1,100 miles north. There were two days upon which we saw nothing but the green sud stretching for miles around us, but generally the monotony of the green papyrus was broken by natives in primitive dug-out canoes drifting along, or spearing fish in the rushes at the water's edge. We saw various different types of natives, wilder-looking men than we had seen before, with warlike weapons and weird and wonderful forms of head-dress, their jet-black bodies ornamented here and there with beads, copper wire, or bands of ivory. The Bahri and Shilluk tribes frequent the Nile banks in this part, but one wonders how they exist on this barren land. At most of our calling-places, however, we saw a few bags of rain-grown cotton prophetic of future cotton-growing developments.

During our stay in Khartoum we paid a visit to Senaar, passing through the cotton fields of the Sudan Plantations Syndicate (Fig. 5). The dam across the Blue Nile at Makwar was at a most interesting stage, the foundations at the deepest point being satisfactorily negotiated. We were informed that the contract would be completed to time, and that new cotton areas would be irrigated next season. The barrage when finished will allow a railway to cross it and connect the new line at Kassala with Khartoum and the Kordofan.

From Khartoum we continued north to Egypt, and when we reached Assuan we felt our real travels were ended, for we were now on the tourists' route.

We visited the Valley of the Kings and Tutankhamen's tomb while staying in Luxor, as well as some of the many temples that are the wonders of ancient Egypt, and after a pleasant week in Cairo we continued to Port Said, and from there sailed back to England.

During the whole of our journey we received the greatest kindness and assistance from colonists and Government officials. Everyone was interested, either directly or indirectly, in cotton-growing, recognizing that the prosperity of the country depended largely upon it, and that only by opening up new roads and railways could the development of this part of Africa be achieved.

A NOTE ON THE RAW COTTON EXHIBIT AT WEMBLEY

(Palace of Industry.*)

" Look, Mummy, engines !"

" No, my dear, that's a model bakery."

This conversation, overheard in the cotton machinery room at the Exhibition, displays what is possibly an unusual degree of ignorance, but at the same time it goes to show that there are many people who know little or nothing about the greatest industry of the country. Another lady visitor enquired what was the difference between cotton that " grew on a sheep's back and that which grew upon a plant "; while a third, on seeing the pictures of the boll-weevil, said, " So that's the funny little animal that makes the cotton, is it ?" Numerous people mistook the raw cotton for wool; and so on. If the wonderful exhibit of Empire cotton has served no other purpose, it may have done much towards instruction.

The cultivation of cotton is practicable in many parts of the Empire, and all, whether in Europe, Asia, Africa, America, or Australia, were represented in the show of raw Empire cottons placed in the portico and half of the handsome pavilion occupied by the four exhibiting bodies,* who pooled their resources. The exhibit must have appealed to the uninstructed by its range, and to the initiated by the variety of types and qualities of cotton which it presented, cottons often requiring the eye of a trained specialist to appreciate and evaluate their differences.

The cottons were shown in bales and in sample, and also as individual seeds with the fibres combed out in halo fashion. On counters were samples of Empire cottons with a range of Liverpool standards of American and other growths for comparison. Good comparison could even be made by night by the aid of the Macbeth daylight lamp provided. These samples showed that the Empire cottons are in general as good as their rivals in quality and staple, so that were the American supply gradually to cease, as appears to be quite within the range of probability, a gradual extension of Empire growth might take its place without injury to the quality of the goods produced.

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* This article refers only to the exhibit made in the Palace of Industry (K. 352) by the Empire Cotton Growing Corporation, the British Cotton Growing Association, the Liverpool Cotton Association, and the Manchester Cotton Association. India, Australia, South, East, and West Africa, and the West Indies all had separate representative exhibitions of their own.

Maps illustrating the areas of cultivation—actual and possible—were also shown, and at once drew attention to the great possible areas, and to the prevailing lack of transport facilities. There were also good exhibits of cotton pests to which the crop is so subject.

This collection of varied and excellent cottons reflects great credit upon the foresight and the pioneering energy of the British Cotton Growing Association, who have been the principal agents in overcoming the preliminary and most formidable difficulties in the way of extension of cultivation. It is interesting to note, moreover, that the quality and range of these cottons surprised many of the American and foreign visitors to the Exhibition.

As by the time this article appears in print the Exhibition will be nearly over, and as it is written for the overseas reader, no special mention is made of the very interesting exhibit of operative machinery which every Colonial visitor who has to do with cotton should, of course, have seen and studied. Uganda cotton was actually being spun at 40s. counts, and in the opinion of many visiting spinners was showing very good results, especially under the existing atmospheric conditions. Gins of various kinds, worked by hand and power, were also demonstrated.

FURTHER USES OF THE BALLS SLEDGE SORTER

BY

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I. THE STATISTICAL ANALYSIS OF LINT LENGTH.
II. A NEW METHOD FOR ESTIMATING THE NUMBER OF HAIRS PER SEED.

I. THE STATISTICAL ANALYSIS OF LINT LENGTH.

THE best-known method of estimating the length of the hairs in a sample of cotton is by pulling. This is admirably described by Dr. W. L. Balls in his monograph, " The Development and Properties of Raw Cotton," p. 183,[1] from which the following extract is taken:

> " The grader takes opposite sides of a lump of lint in the whole grip of each hand and draws them apart; he then grips the projecting fringe of one half between the finger and thumb along a straight line and draws again; the distance from the grip to the end of the fringe gives the length, and the ' hardness of the edge ' gives the regularity of length. The details of pulling vary between different places, and between the graders of different kinds of cotton, some laying the pulled fibres repeatedly over one another, and then extracting a tuft from the parallelized group and placing it on the coat-sleeve. This latter method is the more objectionable of the two, in that it extricates the longest fibres every time; but the same objection applies to both—namely, that the measurement is a measurement of the longest fibres and of the strongest fibres. This is unimportant to the skilled grader, who knows instinctively how to allow for it, but it leads to complete misunderstanding on the part of amateurs who attempt to copy him; and it should be remembered that any person who has spent less than ten years in the daily grading of cotton, and has not in addition been born with the instinct implanted in him, is an amateur at cotton-grading."

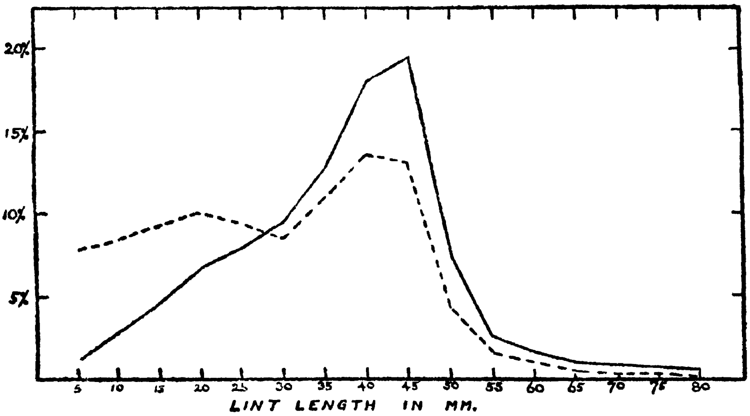
Actual measurements may, of course, be obtained by laying a single fibre on a sheet of black paper, straightening it with the finger, and applying dividers first to the hair and then to the scale, but these operations are rendered almost useless by the extreme difficulty of securing a true sample for examination. The microscope should always be used to ensure that fibres are unbroken. If these precautions are taken, then, according to Balls (*loc. cit.*): " The measurement of 100 fibres gives a probable error of 1 per cent., or of 25 fibres 2 per cent." But at the best of times it is a tedious process, involving considerable eye-strain.

The Balls halo method is better than the above two, but is at a disadvantage in that it can only be applied to seed cotton. The sample to be examined is divided into a number of small heaps—say ten. Each lot is separated into equal parts and the most obvious seed is selected for examination, and in this way the sampling is as nearly random as can be. The lint on each seed is then combed outwards on either side with a small tooth comb; the seed with its halo of lint is then laid on some dark cloth background and the maximum length of lint is measured with a pair of dividers. It is important that the scale be not applied directly, for if this is done subjective errors are bound to creep in. The mean of ten seeds—*i.e.*, twenty measurements—has a probable error of less than 0·5 per cent.

The superiority of the combing method over the other two is obvious, for it gets rid of the variations in the length of lint on one seed and leaves only the fluctuations from seed to seed to be overcome by sampling. Moreover, the results are amenable to statistical treatment, so that a numerical statement can be prepared of a known and high degree of precision. As a medium for measuring the maximum lint length the method leaves little to be desired. In other respects it is far from being satisfactory, as it gives no insight whatever into the uniformity, which is probably quite as important as the maximum length. A machine called the sorter,[2] which has been devised by Dr. Balls, helps in this respect, and is now being used in St. Vincent. By the use of this the lint from a portion of a previously prepared sliver[3] is deposited along a strip of plush in such a manner that the position of the hairs on it is an index of their length. The lint on the plush is then gathered into groups differing in mean length by say 5 mm., and these are weighed separately on a micro-balance; the figures are calculated as percentages, and a frequency distribution by weight is obtained. If the weight per centimetre is known, these figures can readily be converted into numbers of hairs.

The micro-balance used in St. Vincent was home-made, the beam being a capillary glass tube, and the suspension a very fine glass rod. Originally sealing-wax was used for all the joints, but its viscosity proved very troublesome at tropical temperatures; shellac gave better results.

The mean weight per centimetre can easily be determined as follows: A small tuft of lint is combed so that the fibres lie approximately parallel and the parallelized tuft is then placed between two 3-inch by 1-inch glass slides, under the microscope, and by the aid of the mechanical stage the number of hairs in it is readily counted. About 100 hairs is a suitable number. The fibres are then carefully removed from the slides and brought into a bundle, with all the fibres still parallel, gummed by their ends to a piece of paper to facilitate manipulation, and a portion of 2 cm. length cut accurately from the middle. The hairs cut out are then rolled up and hung on the hook of a micro-balance, and the weight calculated to that of a single fibre. The assumption is made that this value is approximately true for any centimetre in any part of any fibre.



EXPLANATION:

CURVES FOR THE MEAN OF 20 OBSERVATIONS ON STRAIN H 23.

Continuous line = percentage distribution by weight.
Broken line = percentage distribution by number of hairs.

Typical curves which have been obtained, using the sorter, are reproduced. It will be noticed that the end classes are always more or less fictitious (see [2], p. 41) on account of a small amount of fluff and fly being dragged forward by the machine, so that it is not possible to determine accurately the maximum lint length. In spite of this serious drawback the data obtained are very valuable, and with suitable treatment can be made to yield much information on the question of uniformity and variability.

In studying the question one must realize that there are two distinct kinds of uniformity of lint length in respect to a particular strain of cotton. First, the amount of variation which exists in the lengths of the hairs of a single typical plant, which in turn depends upon the frequency distributions of lint length per seed; and second, the amount of variation of or difference between the frequency distributions of lint length for the various plants in the same strain. The second can only be studied when we have collected enough data about the first, and such data can be obtained by means of the sorter.

It has been found convenient to present the results as immediately obtained in the following way:

Class Centres in Millimetres.	*Weight in Milligrammes.*	*Percentage.*
5	0·5	0·8
10	2·3	3·8
15	4·6	7·7
20	4·7	7·8
25	5·1	8·5
30	5·2	8·7
35	6·1	10·2
40	11·2	18·7
45	12·1	20·2
50	5·9	9·8
55	1·0	1·7
60	0·5	0·8
65	0·3	0·5
70	0·2	0·3
75	0·2	0·3
80	0·1	0·2
	60·0	100·0

The particular cotton which gave the figures in the table was found by combing to have a maximum lint length of 51·2 mm., which demonstrates that the end classes are entirely fictitious.

It will be observed that the classes for lint length extend to 80 mm., whereas in the original state of the machine the maximum length allowed for was 60 mm. It was found that the sorter, in this condition, was unsuitable for our very long cottons, and after a consultation, Dr. Balls arranged for the gearing ratio to be altered in our instrument. Subsequently the machine has worked satisfactorily.

The percentage figures when plotted form a skew curve with the mode a little distance from the mean; but in comparing several such sets of observations, it is convenient to regard the curve as one of normal error, and to calculate the standard deviation and coefficient of variability in the usual way. The propriety of such a procedure is open to doubt, and it should be understood that this is done merely for convenience, and does not claim to be more than an approximation. That such a treatment is far from meaningless is shown by the following figures:

Strain V. 135. Plant No.	*Mean Lint Length by Sorter.*	*S.D.*	*C.V.*
1	38·98	16·48	42·2
2	39·50	17·00	42·5
3	37·67	16·57	43·0
4	38·45	16·40	42·6
5	37·64	16·92	44·9

$M_{c.v.} = 43{\cdot}04 \pm 0{\cdot}28$. $M_{s.d.} = 16{\cdot}67$.

Strain H. 23. Plant No.	*Mean Lint Length.*	*S.D.*	*C.V.*
1	29·6	11·8	29·8
2	34·8	13·0	37·6
3	34·8	12·9	37·4
4	37·4	13·2	35·4
5	38·0	13·0	34·1

$M_{c.v.} = 34{\cdot}86 \pm 0{\cdot}85$. $M_{s.d.} = 12{\cdot}78$.

The probable errors of the means of the coefficients of variability are surprisingly low, considering the very small number of plants examined, which indicates that the method has a fairly high degree of precision. From the figures it seems clear that the variability per plant is greater for V. 135 than for H. 23. Such a conclusion could hardly have been drawn from the data without statistical treatment, though, as mentioned above, the validity of treating a skew curve as a normal curve of error may be questioned.

We have thus far compared the intra-plant variability—*i.e.*, the estimation and comparison of the amount by weight of hairs that occur in a single plant. The frequency distribution by weight and its coefficient of variability is apparently a true measure of the variability of lint length on a single plant; such frequency distributions are broadly similar for all plants taken from the same pure strain, or at any rate standard deviations and coefficients of variability calculated from them are grouped about a constant mean. Different strains may have different means about which these coefficients are grouped. Further, if the strains were impure, one would expect that the amount of variation in lint length per plant would be by no means the same for all plants—*i.e.*, the values obtained for C.V. would vary considerably. A figure for comparing variations per plant—*i.e.*, for comparing the variations in the value of C.V.—can be obtained by finding the " coefficient of variability of the coefficients of variability," or $C.V.^2$. The values of $S.D.^2$, or the "standard deviation of the standard deviations," have also been calculated, but their use for comparative purposes is probably misleading where the means of the various groups of standard deviations to be compared are not the same.

Some figures which have been calculated may be summarized as follows:

Strain.	$M_{s.d.}$*	$S.D.^2$	$M_{c.v.}$	$C.V.^2$
H. 23	13·11	0·68	35·4	6·4
(H. 23 × V. 135) F_1.	14·26	0·99	35·1	6·7
V. 135	16·00	1·19	42·3	6·9

These figures may be taken to show that—

(1) The strain H. 23 has a more uniform lint length than V. 135.

(2) The variability of the F_1 is intermediate between that of the two parents, and hence the character "uniformity of lint length" may be inherited on Mendelian lines.

(3) The variation in the extent of variability from plant to plant is roughly the same for both the parents and their F_1. This is to be expected, since previous breeding work has led to the supposition that all the plants in any one group have the same genetic constitution.

There seems to be no adequate reason, apart from the question of time consumed, why the value of C.V. for individual plants should not be used as a basis for selection work. In this way there should be less difficulty than heretofore in deciding which are the most uniform plants.

II. A NEW METHOD OF ESTIMATING THE NUMBER OF HAIRS PER SEED.

That variations in lint per cent. were due to variations in the number of hairs per seed was deduced by Balls in Egypt from the analysis of data obtained from daily pickings of cotton.[1] Checking this conclusion by direct observation he considered impossible, and consequently attempted an indirect method. By taking single hairs from a sample of lint and laying each on a piece of black paper and measuring with dividers, the mean length of his super-sakel strain 310 N was reckoned to be 41 mm., probably too high a figure. He then says (*loc. cit.*, p. 107): ". . . The weight of lint on a single seed is about 0·033 gramme; since 10 millimetres of a single lint hair in its thickest part weighs 0·00122 milligramme, one hair will weigh about 0·00400 milligramme, and there must consequently be about 8,000 hairs on a single seed." In the same year Leake published in the *Journal of Genetics* his entirely independent work on the same point. He actually succeeded in counting directly the number of hairs per seed, and showed that the differences in ginning out-turn were proportional to these numbers.

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* Twenty plants were examined for each of the three types.

By using the Sledge Sorter data in conjunction with lint index and weight per centimetre determinations, an easier and probably more accurate method can be evolved.

When the weight per centimetre has been determined, in the manner described, the percentage by weight figures for each class obtained by the sorter can be regarded as absolute weights in milligrammes, and can readily be converted into numbers of hairs. In one particular case the figures were as follows:

WEIGHT PER CENTIMETRE. 0·00110 MILLIGRAMMES.

Class Centres in Millimetres.	*Weight in Milligrammes.*	*Percentage.*	*Numbers of Hairs.*
5	0·3	0·8	1,455
10	0·7	1·8	1,636
15	1·1	2·8	1,697
20	1·6	4·1	1,864
25	2·2	5·6	2,036
30	2·5	6·4	1,939
35	4·1	10·4	2,701
40	8·4	21·3	4,841
45	9·4	23·8	4,808
50	4·3	10·9	1,982
55	2·0	5·1	843
60	0·8	2·1	303
65	0·7	1·8	252
70	0·4	1·1	130
75	0·6	1·5	182
80	0·4	1·0	114
		100·5	26,783

The first column shows the mean length of the hairs in the group as determined by the sorter. The second column shows the weight of each of these groups in milligrammes as found on the micro-balance.* The third column shows the same figures as percentages, and the fourth column gives the number of hairs per group calculated from the percentage figures and supposing them to have absolute weight in milligrammes.

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* The weights given in the example are almost certainly not accurate owing to errors in the calibration of the micro-balance, and consequently the figures for numbers of hairs are not quite correct. This, however, does not affect the validity and usefulness of the method.

Obviously the sum of the number of hairs in each class gives us the number of hairs in a sample of cotton of known weight.

In this case 100·5 milligrammes contain 26,783 hairs. The mean weight of lint per seed for this plant was 0·0364 gramme, and consequently each seed has on the average 9,700 hairs—say 10,000. If the observations are based on the means from several different plants a more accurate statement can be obtained; there is in any case a slight error, as the classes above 55 mm. are largely fictitious, but the errors are probably far less than when the method of sampling is by pulling isolated fibres from a sample of lint.

Working in this way, the conclusions of Balls for Egyptian, and Leake for Indian, are shown to be true of Sea Island also. Data obtained for two strains and their F_1 are given.

Strain.	*Weight of Lint Per Seed.*	*Number of Hairs Per Seed.*
H. 23	0·055	16,400
(V. 135 × H. 23) F_1	0·048	13,300
V. 135	0·038	11,700

Thus the weight of lint per seed is roughly proportional to the number of hairs per seed, and further, the number of hairs per seed is roughly intermediate in the F_1. The character is therefore probably inherited on Mendelian lines.

SUMMARY.

I.

1. An account is given of the various methods in use for estimating the length of staple of a sample of cotton.

2. It is pointed out that the only method which gives any true insight into the proportion of hairs of various lengths in a sample is by the use of such a machine as the Sledge Sorter devised by Dr. Balls.

3. A method of statistical analysis of the results from the machine is described by means of which one can prepare a numerical statement of the uniformity of lint length of a sample.

4. The method shows clearly the differences in uniformity between different plants.

5. Groups of plants may have differences in the range and extent of their variation, and such differences can apparently be demonstrated and measured.

6. It is suggested that by using the method of analysis described selection work towards a more uniform lint length should be possible.

7. The character uniformity may be inherited along Mendelian lines.

II.

1. Existing methods of estimating the number of hairs per seed are discussed.

2. A new and better method is described for making the estimation, involving the use of the Balls Sledge Sorter.

3. It is shown that the weight of lint per seed is proportional to the number of hairs per seed.

4. The number of hairs per seed may be inherited along Mendelian lines.

LITERATURE.

[1] DR. W. L. BALLS: "The Development and Properties of Raw Cotton." A. and C. Black and Co., London, 1915.

[2] DR. W. L. BALLS: "A Method for Measuring the Length of Cotton Hairs," *Fine Spinners' Industrial Handbook,* 1920.

[3] A. J. TURNER: "The Spinning Value of Cotton," THE EMPIRE COTTON GROWING REVIEW, vol. i., No. 2, April, 1924, p. 111.

COMPARATIVE COTTON PRICES

BY

JOHN A. TODD, M.A., B.L.

In discussing the question of cotton prices from a statistical point of view, the only difficulty is to select from the wealth of material available those statistics which are most likely to interest the various readers of the Empire Cotton Growing Review.

It may be assumed that the first point upon which all will be agreed is the desirability of an historical background and a record of highest and lowest prices. In the "World's Cotton Crops"* the writer gave a compilation of all the information he had been able to collect as to the prices of the chief varieties of cotton, and the following (Table I.) is selected from it. It gives the prices at ten-year intervals from 1799 to 1899 and yearly thereafter—*i.e.*, over a total period of 125 years.

In order, however, to get a true perspective of these prices of the old days as compared with now, it is necessary to have some parallel indication of the general movement of all prices, and for this purpose the last column of Table I. gives a continuous index number throughout the whole period. From this it is possible to trace how far the great movements of cotton prices coincided with, and presumably to some extent at least were caused by, the movements of general prices, and how far they were due to conditions especially affecting cotton.

As the years selected do not happen to contain either the maximum or the minimum prices ever touched by cotton, it may be interesting to note that the highest price recorded, so far as known to the writer, was in 1786 as the result of the American war. In that year Ellison quotes "very fine Bourbon" at 7s. 6d. to 10s. a pound. The other periods of high prices were in 1799 and 1809, when Sea Island was over 5s. a pound. In 1814 Sea Island again went to 6s. per pound, so that the high prices of the cotton famine of the sixties, to which until 1920 we used to look back with awe, were not really the highest records. But they were high enough in comparison, because between the twenties and the sixties there had been a period of low years (about 1845) when cotton prices fell to levels then unknown, for American was down to 3¼d. a pound, and Indian to 2d.

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* 1924 Reprint Table F. I.

During the cotton famine of the sixties, the highest prices that the writer has been able to trace were 31¼d. for Egyptian in 1864, and 31¾d. for American in the same year*—these in Liverpool. In America the figure for 1863 is given as 101½ cents, but that was probably the year's average, and is subject to question as to the value of the currency.

The fall after the Civil War became merged in the great general fall of prices from 1873 onwards, which carried cotton to the lowest levels on record, when in 1894 and 1898 American Middling was below 3d. a pound. It may be noted in passing that the average yields of American cotton in 1892 (209·2 lbs.) and in 1898 (220·6 lbs. per acre) were the highest recorded since 1866. It is also interesting to note that the general level of prices turned in 1896, and rose pretty steadily till 1913. It will be seen again, however, from a comparison of the index number and cotton prices, that during the first part of this century—*i.e.*, before the War—cotton prices were rising more rapidly than the general index number, this being due to the steady increase of the demand for cotton and the uncertainty of the American supplies.

After the first great slump in cotton on the outbreak of war it soon recovered, though the recovery in cotton was slower than the rise of the general index numbers until 1916-17. The highest point touched during the War was in June, 1917, when the intensive submarine campaign seriously interfered with the imports from America, and Middling American touched 19·45d. in Liverpool. This, however, was still far behind the record of the sixties, and it remained for the great post-war boom of 1919-20 to establish new records which were only beaten by the rather vague figures of 1786. The highest actual price the writer has been able to trace was 32·41d. for fully Middling in Liverpool on February 18, 1920. On that date Middling was 31·16d. in Liverpool, and the highest point was reached the day before for Egyptian (fully good fair Sakellaridis, 99·00d.).

The next point of interest is the comparative prices of different varieties, and for this we have taken out a continuous monthly record since 1919 in two tables. The first contains the comparative spot prices of American and Egyptian cotton in Liverpool, Alexandria, and New Orleans, with the premium of Egyptian over American in Liverpool shown as a percentage. Table III. contains similar prices of other kinds of cotton in Liverpool for comparison. (It may be noted in passing that a yearly record of Indian prices with the percentage on American was given in the April issue.) 1919 has been chosen as the commencement of this series, in the first place because it gives details of the movement of prices during the post-war boom and the deflation slump, and also because it shows the effect since then of the increasing alarm with regard to the supply of American cotton.

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* Williams' "Seven Years' History of the Cotton Trade of Europe, 1861-1868."

The main points of interest to be noted in these two tables may be briefly indicated as follows:

1. The effects of the periodic scares with regard to the American crop, some of which proved to be false alarms, especially that of 1921 due to the serious understatement of the acreage in that year by the Department of Agriculture.
2. The extraordinary movement of the premium of Egyptian over American, first during the boom of 1919, which was largely due to an unintentional corner created in Alexandria by the American demand for Egyptian cotton for tyre fabric, and second, the extraordinary slump in Egyptian prices which resulted partly from the collapse of the tyre boom, and still more from the shortage of American and the resulting demand for Egyptian, especially Uppers. The effect of that is shown in a very striking way by the relative prices of Uppers given in Table III. and Egyptian in Table II.

TABLE I.—HISTORY OF COTTON PRICES, 1799-1924.

Season.	*Liverpool Prices (Pence per Lb.).* *Sea Island.*	*Brazil.*	*American.*	*Indian.*	*Egyptian.*	*Alexandria.*	*American Price of Upland*	*Year.*	*Index Numbers of General Prices.*
	HIGHEST AND LOWEST.					YEARLY AVERAGES.			1900 =100
		Pernam.	Bowod Georgia.	Bengal and Surat.		Dols. per Kantar.	Cents per Lb.		
1799	42–63	29 –56	17 –42	11 –28	—	—	28·0	1799	218
1809	28–69	22½–38	14 –34	11 –26	—	—	16·0	1809	262
1819	21–48	16 –23½	10 –19¾	5¾–14½	—	—	17·0	1819	187
1829	9–21	6⅜–8½	4⅝–7	2⅞–5½	5⅞–8½	12·00	10·0	1829	132
1839	*20–22	9 –11	5¾–10¼	4½–6¾	*11–12¼	13·00	9·9	1839	153
1849	—	4¾–7⅛	3⅜–7⅛	2⅞–5	—	11·75	12·3	1849	107
	YEARLY AVERAGES.								
		Pernam Fair.	Middling.	Fair Surat.					
1859	—	8·25	6·75	5·00	—	12·25	11·00	1859	128·0
1869	85·3	12·50	12·12	9·75	—	19·50	24·00	1869	131·0
1879	27·5	6·81	6·31	5·00	—	14·34	12·00	1879	125·0
1889	21·7	6·31	5·94	4·19	¶7·44	13·61	11·50	1889	103·4
1899	16·7	3·94	3·56	‡3·03	5·44	12·28	7·60	1899	92·2
	SEASON'S AVERAGES.								
1899–1900	16·7	5·06	4·87	§4·40	**6·81	12·28	7·60	1900	100·0
1900–01	16·4	5·50	5·16	4·37	6·87	13·80	9·30	1901	96·7
1901–02	19·3	4·87	4·78	4·19	6·31	10·42	8·10	1902	96·4
1902–03	†25·00	5·57	5·44	4·47	8·44	13·65	8·20	1903	96·9
1903–04	28·40	5·16	6·94	5·56	8·56	16·65	12·16	1904	98·2
1904–05	27·12	5·25	4·93	4·62	7·37	13·97	8·66	1905	97·6
1905–06	26·38	6·23	5·94	5·00	9·25	15·99	10·94	1906	100·8
1906–07	36·70	6·97	6·38	4·87	10·37	19·16	10·01	1907	106·0
1907–08	35·59	6·79	6·19	5·03	8·81	18·21	11·46	1908	103·0
1908–09	23·39	5·84	5·50	4·94	8·44	15·46	9·24	1909	104·1
1909–10	32·85	8·34	7·86	‡6·06	13·12	23·30	14·29	1910	108·8
1910–11	35·62	8·27	7·84	6·78	10·75	20·66	14·69	1911	109·4
1911–12	23·73	6·70	6·09	5·44	9·56	17·25	9·69	1912	114·9
1912–13	25·00	7·11	6·76	5·91	9·79	18·28	12·20	1913	116·5
1913–14	23·47	7·47	7·27	5·62	9·45	19·02	13·49	1914	117·2
1914–15	22·00	5·71	5·22	4·19	7·34	12·01	7·94	1915	143·9
1915–16	27·00	8·22	7·51	5·79	10·42	19·28	11·99	1916	186·5
1916–17	50·00	13·03	12·33	9·92	21·56	37·81	18·41	1917	243·0
1917–18	80·00	24·13	21·68	16·10	‖30·97	38·52	28·86	1918	267·4
1918–19	65·00	23·96	19·73	17·15	27·85	37·20	30·36	1919	296·5
1919–20	—	30·00	25·31	18·05	60·34	87·81	38·21	1920	371·4
1920–21	—	13·24	11·89	8·21	30·24	34·50	16·08	1921	229·6
1921–22	—	11·40	11·37	8·72	19·75	34·28	17·78	1922	185·0
1922–23	—	14·62	14·92	10·25	17·29	30·71	24·06	1923	185·3
1923–24	—	18·20	17·66	12·37	21·55	††39·77	31·67	1924	—

* Last week only. † South Carolina. ‡ No. 1 Good Oomra. § No. 1 Fine Oomra. ‖ F.G.F. Sakel. ¶ G. F. Brown. ** F. G. F. Brown. †† 10 months' average. These prices are F. G. F. Brown till 1914, since then G. F. Sakel.

TABLE II.—SPOT PRICES OF AMERICAN AND EGYPTIAN COTTON IN LIVERPOOL, ALEXANDRIA, AND NEW ORLEANS ON THE LAST FRIDAY OF EACH MONTH.

Month.	*Liverpool.* *American Fully Middling.*	*Liverpool.* *Egyptian F. G. F. Sakel.*	*Premium per Cent.*	*New Orleans, American Middling.*	*Alexandria F. G. F. Sakel.*	*Premium per Cent.*
	Pence per Lb.	Pence per Lb.		Cents per Lb.	Dollars per Kantar.	
1919–20.						
August ..	19·70	30·00	52	31·25	58·50	87
September ..	20·48	30·00	46	32·13	53·50	67
October ..	25·05	35·50	42	39·00	63·50	63
November ..	25·48	45·00	78	39·00	82·50	111
December ..	27·59	51·00	85	40·00	97·50	145
January ..	29·56	77·00	160	39·88	142·00	256
February ..	31·02	92·50	198	40·25	154·00	284
March ..	29·38	83·00	184	40·25	161·00	300
April	27·08	84·50	211	41·25	154·00	275
May	27·35	75·50	176	40·00	126·00	215
June	27·63	63·00	128	39·75	105·00	165
July	27·40	67·00	145	38·75	130·00	235
1920–21.						
August ..	23·74	67·00	182	30·75	125·00	306
September ..	23·10	57·00	147	26·50	89·00	236
October ..	18·05	43·00	138	21·00	74·00	252
November ..	12·73	30·00	136	15·50	39·00	152
December ..	9·90	22·00	123	13·50	32·00	137
January ..	9·79	21·00	115	14·25	33·00	132
February ..	7·61	14·00	84	11·75	20·50	75
March ..	8·80	17·50	99	11·50	33·00	186
April	7·99	17·75	122	11·25	30·50	170
May	8·27	16·50	100	*11·75	*27·50	135
June	7·65	15·50	103	10·38	26·50	156
July	8·33	15·50	86	11·00	29·00	164
1921–22.						
August ..	10·01	16·25	62	14·50	31·00	115
September ..	15·22	27·75	82	20·50	57·00	178
October ..	12·72	23·50	85	18·75	42·00	125
November ..	12·04	20·50	70	17·50	40·50	131
December ..	11·71	21·50	84	17·75	41·50	135
January .	9·61	16·00	66	15·25	30·50	100
February ..	10·60	17·75	67	17·13	35·50	108
March ..	10·84	17·75	63	16·63	35·75	115
April	10·36	17·50	69	17·00	35·00	106
May	11·84	18·75	58	20·25	37·00	83
June	13·23	19·75	49	21·50	37·50	74
July	13·24	18·00	35	21·50	35·00	63

May 20.

TABLE II.—SPOT PRICES OF AMERICAN AND EGYPTIAN COTTON IN LIVERPOOL, ALEXANDRIA, AND NEW ORLEANS—*Continued.*

Month.	*Liverpool.*		*Premium per Cent.*	*New Orleans, American Middling.*	*Alexandria F. G. F. Sakel.*	*Premium per Cent.*
	American Fully Middling.	*Egyptian. F. G. F. Sakel.*				
	Pence per Lb.	Pence per Lb.		Cents per Lb.	Dollars per Kantar.	
1922–23.						
August ..	13·70	18·00	31	22·00	35·00	59
September ..	12·40	17·00	37	20·25	32·00	58
October ..	14·29	17·75	24	23·50	32·00	36
November ..	14·85	18·50	25	25·50	34·50	35
December ..	15·34	17·90	18	26·50	33·25	26
January ..	16·42	18·25	11	28·25	33·75	19
February ..	16·44	17·50	6	29·75	33·00	11
March ..	15·16	17·50	15	29·00	33·25	14
April	15·56	17·15	10	28·25	32·75	16
May	16·02	16·40	2	28·50	31·75	11
June	16·67	16·20	3	28·75	31·00	7
July	14·57	15·50	6	23·00	27·75	29
1923–24.						
August ..	15·18	16·75	10	24·75	31·50	27
September ..	17·11	18·35	7	28·50	34·87	22
October ..	17·88	18·75	5	30·50	34·87	14
November ..	21·72	26·70	23	35·75	50·37	41
December ..	21·17	24·30	15	36·00	45·62	27
January ..	19·81	23·35	18	33·50	44·62	33
February ..	17·63	20·50	16	29·63	40·50	36
March ..	16·46	20·60	25	27·50	40·00	46
April	18·20	23·40	28	30·88	44·62	44
May	18·23	23·10	27	30·88	44·87	45
June	17·43	23·60	35	28·80	44·37	54
July	18·29	25·00	37	30·00	47·27	58
1924–25						
August ..	*16·76	25·15	50	24·82	47·75	92

Standard Middling.

TABLE III.—MONTHLY SPOT PRICES OF VARIOUS KINDS OF COTTON IN LIVERPOOL, 1913-21.

On the last Friday of each Month. From the Liverpool Cotton Association's Weekly Circulars.

(For American in Liverpool and New Orleans—and Egyptian in Liverpool and Alexandria—see Table II.)

Seasons.		*Egyptian Uppers (F.G.F.).*	*Peru Smooth (Good Fair).*	*Peru Rough (Good Fair).*	*Peruvian Affi (Good Fair).*	*Brazilian Pernam (Fair).*	*West African (Middling).*	*East African (Good Fair).*	*Indian No. 1. Good (Oomra).*
1919–20.									
August	29	26·50	24·48	29·00	24·50	21·90	18·85	24·20	17·10
September	26	26·50	25·78	28·00	25·00	22·78	19·63	24·90	16·20
October	31	32·50	34·06	30·50	30·50	29·15	25·00	29·05	17·60
November	28	43·00	33·96	33·50	36·50	29·08	23·63	31·00	18·60
December	24	49·00	39·34	38·00	45·50	32·34	24·99	34·00	19·85
January	30	71·00	41·80	44·00	58·00	34·56	28·56	44·00	20·35
February	27	72·50	42·72	45·50	77·00	35·27	28·77	49·50	20·85
March	26	66·00	41·38	45·50	71·00	33·88	27·38	48·75	19·35
April	30	60·00	40·08	46·00	69·00	31·58	26·08	48·00	18·50
May	26	51·00	39·08	46·00	59·00	30·58	25·08	47·25	17·25
June	25	41·00	40·28	43·00	56·00	30·38	25·36	47·50	15·75
July	30	46·00	40·90	39·00	52·00	28·90	25·65	43·50	15·50
1920–21.									
August	27	39·50	36·74	36·00	53·00	24·74	21·49	39·50	13·75
September	24	30·50	33·35	29·00	44·00	23·35	20·10	36·00	13·75
October	29	23·00	25·80	22·00	24·00	17·80	16·30	26·00	11·25
November	26	15·50	18·23	18·00	22·00	13·23	11·73	18·00	8·75
December	31	14·00	13·90	13·00	17·00	9·90	9·40	14·50	6·75
January	28	14·00	11·89	13·00	16·00	9·39	9·89	13·00	6·75
February	25	10·00	8·61	12·50	11·00	7·11	7·61	10·50	5·35
March	23	12·50	9·42	12·00	13·00	7·92	8·42	9·00	5·35
April	29	12·00	9·49	10·00	14·00	7·74	8·24	8·75	5·25
May	27	11·25	9·82	10·00	14·00	8·07	8·57	8·75	5·40
June	24	10·50	9·20	9·50	13·00	7·45	7·95	8·25	5·00
July	29	11·00	9·83	9·50	14·00	8·08	7·58	8·75	5·85
1921–22.									
August	26	11·25	11·56	9·00	14·00	9·31	9·06	10·25	7·00
September	24	21·00	18·17	14·00	18·00	14·67	14·02	15·00	10·75
October	28	18·00	16·17	13·50	16·00	12·67	12·02	14·50	9·50
November	25	15·50	14·54	13·00	15·00	12·04	10·79	13·00	8·75
December	29	17·00	14·16	13·00	15·00	11·91	10·66	12·75	8·65
January	27	12·75	12·06	12·25	14·00	9·81	8·06	10·25	7·45
February	24	14·75	12·65	12·25	14·00	10·65	8·90	11·00	7·95
March	31	14·25	13·09	12·25	14·00	11·09	9·34	11·00	8·30
April	28	13·75	12·66	12·00	13·50	10·41	8·91	10·50	8·30
May	26	15·00	14·19	12·50	13·50	11·49	10·44	12·25	9·35
June	30	15·75	15·33	13·50	14·00	12·63	11·58	13·25	10·10
July	28	14·00	15·29	13·75	13·30	12·79	11·54	13·50	10·10

TABLE III.—MONTHLY SPOT PRICES OF VARIOUS KINDS OF COTTON IN LIVERPOOL, 1913-21—*Continued.*

Seasons.	*Egyptian Uppers (F.G.F.).*	*Peru Smooth (Good Fair).*	*Peru Rough (Good Fair).*	*Peruvian Afifi (Good Fair).*	*Brazilian Pernam (Fair).*	*West African (Middling).*	*East African (Good Fair).*	*Indian No. 1 Good (Oomra).*
1922–23.								
August 26	14·75	15·55	13·75	13·00	13·20	11·80	14·00	10·45
September 29	13·50	14·25	14·00	13·00	12·15	10·75	13·00	9·45
October 27	15·00	15·99	14·50	13·50	13·89	12·74	13·50	10·20
November 24	16·00	16·85	16·00	14·50	14·60	13·35	14·25	10·65
December 28	15·90	17·34	16·00	14·75	15·09	13·84	14·75	10·45
January 26	16·50	18·27	17·25	18·50	16·37	15·02	15·50	11·45
February 23	16·25	17·89	17·50	15·25	16·14	14·89	15·05	10·80
March 28	16·80	16·51	17·50	16·25	15·01	13·76	14·05	10·00
April 27	16·40	16·36	17·50	16·50	15·11	13·86	14·30	10·00
May 31	15·95	16·51	17·50	16·00	15·47	14·01	14·00	10·15
June 29	16·45	17·32	17·50	16·00	16·07	15·69	14·70	10·40
July 27	15·85	15·57	17·25	15·50	14·07	14·07	13·75	9·85
1923–24.								
August 31	16·75	15·78	17·00	15·75	15·03	14·78	13·50	10·15
September 28	17·60	17·86	17·50	16·75	17·36	16·86	15·75	11·05
October 26	18·05	19·03	17·50	17·25	18·53	17·72	16·25	11·85
November 30	24·65	23·87	21·00	25·00	22·27	21·62	21·00	15·60
December 28	23·30	23·17	22·00	23·50	21·57	20·92	20·75	15·10
January 25	21·90	21·86	23·00	22·50	20·26	19·61	19·50	14·00
February 29	22·10	19·48	22·50	21·25	17·88	17·23	17·80	12·35
March 28	22·10	18·26	22·00	20·00	16·66	16·01	16·65	11·50
April 25	23·25	20·15	22·25	21·75	18·15	17·65	18·70	12·25
May 30	24·00	20·64	22·50	22·00	18·64	18·13	19·50	12·75
June 27	23·20	19·18	22·50	22·00	17·43	16·93	18·35	11·80
July 25	24·45	20·34	22·50	21·50	18·59	18·09	18·45	12·30
1924–25.								
August 29	21·65	17·91	22·50	21·50	16·16	15·66	16·70	10·90

With regard to the statistics given in July, the following letter from the Economic Botanist for Cotton, Nagpur, Central Provinces, is of interest:

In Mr. Todd's interesting statistics of the Indian Cotton crop contained in No. 3 of the Empire Cotton Growing Review, there are one or two errors in Table IV. (f), pp. 222-223, which, if allowed, I should like to point out.

I. The inclusion of Comilla, Burma, etc., in the group II., "Mainly ⅞ inch staple and above" is quite incorrect. Comilla cotton (mostly *Gossypium cernuum*) is the shortest of our Indian cottons. The Burma cotton, though some may be fair and no doubt capable of future improvement, could not generally be placed anywhere than in the shortest staple group.

The cottons covered by the term "Comilla, Burma, etc.," are generally regarded as the poorest staple of all Indian cottons. They could certainly never spin higher counts than 12's, and only that in the case of exceptional selected samples; 6-8's would be the usual count. I notice in "The World's Cotton Crops," p. 35, too, Prof. Todd says: "One variety known as Comilla, from a town of that name in Eastern Bengal, apparently fetches in Liverpool about the same price as Kumta or Dharwar." I do not understand this, for unless someone were especially looking for a sample of Comilla for a special purpose it could certainly be supplied at the lowest price of all Indian cottons. It may be that because of its poor quality it is so rare in Liverpool.

II. In the group I., "Mainly below ⅞ inch staple," a very false impression is given by the inclusion of "Barsi and Nagar" and "Hyderabad Gaorani" amongst the other varieties therein. They stand out far superior to all other cottons in the group. Their staple I should put as mainly ⅞ inch to 1 inch. The greater portion (75%) of the Hyderabad Gaorani will spin 20's and over. It is much sought after by our Indian mills at a high premium over the other cottons in the Oomras group. It is the old "bani" cotton, the best indigenous cotton in India.

Barsi and Nagar (also a Hyderabad cotton) is of somewhat mixed growths, but generally its staple is ⅞ inch. It will spin about 16's.

The above two cottons are generally regarded much below their true value in classification tables such as given, because they are classified as "Oomras cotton," which includes Khandesh, Central India, Berar, and Central Provinces cottons, which latter are very much inferior to them. As one working especially for the improvement of some of the Oomras cottons, I am anxious that the best should be recognized at its proper value.

W. Youngman.

NOTES ON CURRENT LITERATURE

COTTON IN INDIA.

182. COTTON CULTIVATION, PUNJAB, INDIA. By W. Roberts. (From the *Summ. Current Lit.*, B.C.I.R.A., vol. iv., No. 8, 1924. E. 16. Abst. from *Agric. J. of India*, 1924, **19**, 141-145.)

The advantages of large estate farming as adopted in the Punjab are discussed. The land is allocated in large areas for specific purposes, and is worked on the tenant system, the tenant getting half the produce and the landlord the other half. The water rate, land revenue and taxes are paid half by the landlord and half by the tenant. The cost of the supervising staff, implements, etc., falls entirely on the landlord. Owing to the areas being large the system enables qualified men to be engaged as supervisors. An area of 7,000 acres has been allotted to the British Cotton Growing Association, and the system of cotton cultivation adopted is described. Other advantages of the system are uniformity throughout the farm by reason of the instructions issued from day to day as to what operations are to be performed, the establishment of a buying agency, the supply of pure seed, and the possibility of investigating power cultivation as compared with tenant farming.

183. INDIAN RAW COTTON. Anon. (*Times of India*, June 24, 1924, p. 6.)

184. The *Review of Agricultural Operations in India*, 1922-23, recently received, contains, among other matters, an interesting account on pp. 15-29 of the operations of the Indian Central Cotton Committee, and of the research and experimental work, etc., on cotton and cotton pests carried out during the year in Bombay, Madras, Bengal, United Provinces, Central Provinces, Hyderabad, Mysore, Baroda, and Middle and Upper Burma.

185. STUDIES IN GUJARAT COTTONS. Pt. II. By M. L. Patel, B.Ag. (*Mem. Dept. Agr. in India*, vol. xii., No. 5, March, 1924. Thacker, Spink and Co., Calcutta.)

In a previous paper (1921) the author described the various types of cotton grown in Gujarat, and gave a detailed description of the variety known as *goghari* which forms one of the three main types of *Gossypium herbaceum* cultivated there, which is characterized in all its strains by roughness, shortness of staple, and high ginning percentage. The present Memoir deals essentially with the second of the great varieties of *Gossypium herbaceum* of Gujarat, namely that known as *broach desi*, or *lalio*, together with a critical consideration of the environment, chiefly climatic, of the cotton plant in Gujarat, and also with a number of other observations on the general botanical characteristics of *Gossypium herbaceum* cottons.

186. In an article on *The Development of Agriculture in India* by D. Clouston, C.I.E., M.A., D.Sc., Director of Agriculture for the Central Provinces, reprinted in the *Agr. Journ. India*, vol. xix., Pt. II., March, 1924, p. 170, it is stated that "In black cotton soil tracts improved iron ploughs have become very popular; thousands are now being sold there every year, and some cultivators have of late years taken to the system of ploughing land on hire with Turnwrest ploughs after completing their work on their own farms. Another plough which has done exceptionally well in this tract is the Sabul, which is specially suitable for ploughing cotton land in the dry season."

187. A PRELIMINARY STUDY OF THE DEMAND FOR VARIOUS TYPES OF INDIAN COTTON. By B. C. Burt, B.Sc., M.B.E., F.C.S., I.A.S., Sec., Ind. Centr. Cotton Com. Bulletin No. 2. A new and revised edition of the above. *Cf.* Abstract **1**, January, 1924.

COTTON IN THE EMPIRE (EXCLUDING INDIA).

188. ASIA: CYPRUS. *Cotton Cultivation in Cyprus.* Anon. (Abstracted in *J. of Text. Inst.*, vol. xv., No. 6, June, 1924, A. 122.)

189. IRAQ. Advices from Iraq state that the condition of the cotton crop is good. The British Cotton Growing Association generously issued new seed free to those cultivators whose previous cotton sowings had been destroyed by locusts. About 287,000 lbs. of seed have been issued, sufficient to plant about 15,000 acres. Ridge cultivation, which was new to the Arab, is now an established custom, and there is a noticeable improvement in the treatment of the crop as compared with previous years. The boll-worm attack is believed to be normal.

190. AFRICA: RHODESIA (SOUTHERN). (*Rhod. Agric. Journ.*, xxi., No. 1, Feb., 1924.)

Cotton has been planted in the districts of Mazoe, Lomagundi, Hartley, South Makoni, Bubi, Nyamandhlovu, Bulawayo, Umzingwane, and smaller plots in several other districts. Reports show that the crops are making satisfactory progress and give indication of promising yields.

191. SOUTH AFRICA. *Cotton Culture.* By Pieter Koch, B.Sc.Agr., Assist. Chief, Tobacco and Cotton Div., and Manager Rustenburg Exp. Sta. (*Journ. Dept. Agr.*, Union S. Afr., vol. viii., No. 1., Jan., 1924, pp. 39-50.)

192. ZULULAND. It is stated in *African Industries* of April 5, 1924, that it has been decided to form a Co-operative Cotton Growers' Society in Zululand.

193. SUDAN. In a pamphlet entitled *The Cultivated Crops of the Sudan, including Cotton* (Sudan Printing Press, Khartoum), Mr. W. A. Davie, M.A., B.Sc.(Agr.), Assist. Director of Agric. and Forests, says regarding cotton growing in the Sudan:

"Cotton is grown on land artificially irrigated and on land naturally flooded, and a small amount is also grown on rain land. The annual area laid down to cotton varies considerably with the volume of the Baraka and Gash floods. For the period 1905 to 1918 the average annual area under cotton was approximately as follows:

Under artificial irrigation	9,000	feddans.
,, rain	6,000	,,
,, natural flood	27,000	,,
Total	42,000	,,

but in years of good natural flooding this total has risen to close on 90,000 feddans.

"In the near future the main increase will be in land artificially irrigated in the great Gezira plain, and with the completion of the Makwar Dam in 1925 it is anticipated that 100,000 feddans of cotton will be irrigated yearly, this area being capable of expansion to 300,000 feddans when arrangements have been made for additional water storage."

194. UGANDA. In his speech at the opening of the Legislative Council in May last, the Governor, Sir Geoffrey Archer, stated that the outstanding feature of the day in Uganda was the success of the cotton industry, the intense interest being displayed in its development, and its great potentialities. Every effort is being made to keep pace with increased production by developing communications and mechanical transport service, and by the construction of metalled roads.

195. AUSTRALIA. *Cotton in Australia.* By Richard Harding, Secretary to the British Cotton Delegation to Australia, 1922. (Longmans, Green and Co. 1924. Price 12s. 6d.)

Few agricultural products are at the present time in such great demand as cotton, and many people are looking hopefully to Australia as a possible source of the fibre. The book under review is the book that such people require, and is one that every planter in Australia should have at his hand. It gives a clear account, backed by numerous actual figures, of the lands available, with their soils and climates, and points out not only the advantages of cultivation in Australia, but the disadvantages with which the country has to contend, not the least being the scarcity of population. The author thinks that about 500,000 square miles are suitable to cotton, and if one-fifth of that were actually occupied by the crop, the world might have nearly all the cotton that it requires. This, however, would require for cultivation alone a population of six times the entire population of Australia to-day.

Besides the detailed discussions of soils, climates, cultivation, etc., appendices are given dealing with diseases, rainfall tables, and other matters.

COTTON IN THE UNITED STATES.

196. AMERICAN TEXTILE NOTES. By W. Whittam, American Correspondent of the *Textile Recorder.* (Extracted from the *Textile Recorder*, 1924, vol. xli., No. 490, p. 99.)

The recent trend of cotton when analyzed brought out the significant results that an American crop of about 8 million bales in 1921 was selling on December 1 of that year at 16·2 cents. In the following year, a 10 million bale crop was fetching an average of 23·8 cents. on December 1, while last season (1923) the average price on December 1 was 31 cents on a final official estimate of this season's yield of 10,081,000 bales.

COTTON IN EGYPT.

197. SOIL TEMPERATURES DURING THE SHARAQI PERIOD AND THEIR AGRICULTURAL SIGNIFICANCE. PRELIMINARY NOTE ON THE SOIL TEMPERATURE IN SHARAQI LAND. By E. McKenzie Taylor and A. Chamley Burns. (*Bulls.* Nos. 31 and 34. Published by The Government Press, Cairo. Price each P.T.5.)

COTTON IN FOREIGN COUNTRIES.

198. FRENCH COLONIAL COTTON. (Extracted from the *Journal of the Textile Institute*, 1923, vol. xiv., No. 12, p. 322.)

Vigorous efforts are still being made to promote the cultivation of cotton in the colonies in view of the gradual decline of supplies from America. Several of the African colonies appear likely to produce this commodity.

At the laboratory of colonial productions cotton fibres from the Cameroons have been studied, and the following report has been published: "This cotton is of even length, about 27 to 28 mm., and it is fairly, if irregularly, fine. An examination under the microscope, as well as indigo dyeing, show that the thread is very good. Its tenacity is remarkable, its elasticity equally first-class. It is white and rather woolly. It would be suitable for purposes for which ordinary American cottons are used, although possibly not equal to number 40." The output of cotton is increasing on the Ivory Coast. The quantity of the lots brought on the Baouk market was 130,143 kg. in the month of April alone, but this only includes the quantity checked by the administration. The real figure is much higher, for the natives of the neighbouring villages bring their products to the market direct.

In the Togo Colony cotton appears to be a promising form of cultivation, which the Germans made efforts to develop. In several villages it is grown successfully, and some of them furnish a product which compares favourably with the best American kinds. New plantations are being encouraged, and an experimental farm of 200 to 300 hectares has been founded in order to furnish planters with selected seed. Out of nine shelling works founded by Germans, six are still working.

199. China. (Abstracted from the *Textile Recorder*, 1923, vol. xli., No. 489, p. 62.)

The Proposed British Textile School in China.—It is proposed to establish a Textile Technical School in Shanghai to provide training in both theory and practice for Chinese students and mill overseers, so that a body of thoroughly trained efficient Chinese may be available to direct and assist in all matters relating to spinning, weaving, etc., in China. Full details are given.

200. Cotton Spinning and Manufacturing in China. By L. Whitworth M.I.M.E., Consulting Engineer, Shanghai. (See the *Textile Recorder*, 1924, vol. xli., No. 490, p. 55.)

201. Cotton Fabric Manufacture: China, India, Japan. By E. Bingham. (*Textile Mercury*, 1923, **69**, pp. 549-551. Extracted from the *Summary of Current Literature*, B.C.I.R.A., January 24, 1924, vol. iv., No. 1, M. 1.)

A review, based on personal experience, of the conditions existing in the cotton industry of India, China, and Japan. Japan is cited as the only serious competitor to the cotton trade of Lancashire. Especial mention is made of the adverse conditions existing in Indian mills, particularly with regard to temperature and humidity.

202. We have recently received from the Association Cotonnière Coloniale, *Bulletin* No. 67, June, 1924, giving details of cotton cultivation in the various French Colonies.

203. Production of Textiles in French West Africa. (*Journ. Offic. de l'Afrique Occid. Franç.*, 15 Mar., 1924.)

A circular, addressed by the Governor-General of French West Africa to his Lieut.-Governors, relating to the application of the decree of March 6, 1924, organizing the production of textiles in French West Africa.

A clear and reasoned account is given of the various methods to be put into service to encourage the growth of cotton in Africa, and is well worth perusal by anyone concerned with this work. It deals with types of cotton, classification before leaving the colony, improvement of methods, dealing with native producers, irrigation, etc.

Cotton in Belgian Congo. *Cf.* abstract **221.**

CULTIVATION AND MACHINERY: IRRIGATION, Etc.

204. Cotton Variety Tests. By G. Briggs. (*Oklahoma Station Bull.* 141, 1923, pp. 3-15. Extracted from *Exp. Sta. Rec.*, 1923, vol. xlix., No. 5, p. 432.)

"Agronomic and yield data with estimated money values are tabulated and discussed for about forty varieties, and selections of cotton compared at the station from 1916 to 1921 inclusive. Results of the 1922 variety tests at the station are appended, together with directions for growing cotton under boll weevil conditions."

205. REPORT OF FIELD CROPS WORK IN GEORGIA, 1922. (Extracted from *Exp. Sta. Rec.*, December 15, 1923, vol. xlix., No. 6, p. 524.)

Experiments with cotton on a clay loam soil showed little difference between different kinds of rock phosphate, no decrease due to the mixing of lime with acid phosphate as compared with the phosphate alone, and no advantage in applying over 200 lbs. per acre of 3-8-3 fertilizer where the boll weevil was not controlled. Sodium nitrate made its best returns when applied at the rate of 166 lbs. per acre. In a "triangular" experiment with cotton and corn, nitrogen seemed to be the limiting factor rather than potassium or phosphorus. Late thinning gave reduced yields of cotton, and close spacing increased the early pickings but decreased the late ones. Early dusting with calcium arsenate was more effective than dusting after boll weevil infestation had reached 10 to 15 per cent.

206. COTTON EXPERIMENTS, 1922: SOUTH MISSISSIPPI BRANCH STATION. By E. B. Ferris. (*Mississippi Station Circular*, No. 46, 1923, pp. 6. Extracted from *Exp. Sta. Rec.*, Sept., 1923, vol. xlix., No. 4, p. 330.)

Varieties outstanding in acre yields and values included Lone Star 65 and strains of Trice and Delfos. The tabulated results of fertilizer trials showed enhanced yields of seed cotton to accrue from the use of lime. Neither the appearance of the plants nor yields were different whether the fertilizer was applied deep, medium, or shallow. The use of potash in the form of kainite is said to have enabled plants to retain foliage throughout the season. Yield differences were slight whether potassium sulphate or potassium and magnesium sulphate was used, and marked reductions did not accompany the omission of potash. The importance of nitrogen and phosphorus was indicated by the substantial reductions in yield where either was omitted.

207. COTTON CULTURE. (*Work and Expenditures of the Agricultural Experiment Stations*, 1921, p. 43. U.S. Dept. of Agr. Mar., 1923.)

Tests of cotton varieties at the New Mexico station showed Durango to be one of the best for the State, yielding equally as well as some of the more common varieties, and the price received for the lint was practically double that for the shorter staple.

The Alabama station finds the best time for applying nitrate to cotton to be when it is from 3 to 5 inches high. A test of the different forms of nitrogen at the Mississippi station showed very little difference in yield when the same amount of nitrogen in each compound was used. Potash experiments with cotton at the Georgia station, on a clay loam soil, indicated that very small applications of potash were as beneficial as heavy ones.

Experiments in thinning at the Texas station show that if this is done late the results are harmful rather than beneficial, and where the moisture supply is adequate, with proper cultivation and freedom from competing weeds and grasses, cotton may be left more thickly in the row than is usually practised. Results obtained at the Mississippi station indicate that much closer spacing than has heretofore been practised gives decidedly bigger yields, especially under boll weevil conditions.

Very satisfactory results were obtained at the Arkansas station in delinting cotton seed with sulphuric acid* and planting the seed with a corn planter. Sunburning was found to be a very common cause of shedding of bolls.

The Oklahoma station finds no critical period in the formation of oil in cotton seed during growth. Season has a marked effect on the oil yield. The latter is dependent chiefly on the total yield of cotton per acre, and there is no great variation in the oil content of mature seed of different varieties in the same year.

208. COTTON SPACING. By H. B. Brown. (*Mississippi Agricultural Experiment Station Bulletin*, No. 212, 1923.)

"The subject of cotton spacing, or the number of plants to be left per acre, is one of much importance to cotton growers, and it is one that has received considerable attention from various experimenters. Results secured in different places have varied considerably. This was probably due to differences in environmental conditions in different places. The environmental conditions, embracing the biological as well as soil and climatic, have an important relationship to the problem. In this bulletin an attempt is made to review the more important experiments that have been made, and to present original data secured by the Mississippi Experiment Station.

"A number of spacing experiments have been conducted, the majority of which were carried on before the boll weevil spread over the Cotton Belt.

"*Summary of Pre-Boll Weevil Distance in the Drill Experiments.*—In the sixty-four spacing experiments listed, the rows varied in width to some extent, several different drill distances being used, some much more often than others. The character of the soil and climate varied. This tends to make an accurate summary, or set of averages, impossible. Yet a survey of the results given shows that 12-inch spacing in 3½ to 4-foot rows was first in yield in twenty-four tests given. This distance was used oftener than any other, but it averaged best. Boll weevils did little or no damage in any of these tests. On the less fertile land the closer spacing gave better yields in the majority of cases. Results from the Texas,† Mississippi,‡ and Georgia§ Experiment Stations bear out this conclusion. On the rich lands wide spacing gave best yields in a number of cases, but the results varied widely, due probably to differences in rainfall, length of fruiting season, etc.

"*Cotton Spacing under the Boll Weevil Régime.*—Starting in Southern Texas in 1892, the cotton boll weevil gradually spread over the Cotton Belt of the United States. At present (1922) nearly the whole of the cotton-growing territory is covered. The coming of the weevil has brought about decided changes in the culture of cotton. The crop must now be cultivated and handled in such a way as to get maximum fruiting in minimum time.

"*Summary of Spacing Work under Boll Weevil Régime.*—In the eleven different tests conducted under boll weevil infestation, nine gave best yields with a spacing of 12 inches or closer. From this it seems that with heavy boll weevil infestation cotton should be spaced very closely. The only question remaining to be decided is just how close it is to be spaced—that is, how much closer than 12 inches. While leaving the rows unthinned may, in some cases, give the best yields, this is uncertain, and in no case will it be practicable on account of the difficulty of removing grass and weeds. There must be room, between the plants or clusters of plants, for a hoe to work if the grass and weeds are to be removed easily and effectively. This requires a space of 10 or 12 inches, and often more is taken. Hoes used are 7 or 8 inches wide. It is impossible to get a cotton chopper to hit within an inch of the place she is looking at. Too often she is not looking at the row at all.

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* *Cf.* abstracts **143, 146**.

† B. C. Pittuck, "Cotton and Corn Experiments," Texas Agric. Exp. Stat., Bull. 45, 1897.

‡ H. B. Brown, "Cotton Experiments in 1915," Miss. Agric. Exp. Stat., Bull. 173, 1915.

§ R. J. Redding, "Fertilizer, Culture, and Variety Experiments on Cotton," Ga. Agric. Exp. Stat., Bull. 43, 1898.

"If weevil infestation is heavy, it is not practicable to leave the plants close enough in the drill for maximum yields, provided only one plant is left in a hill. This difficulty may be avoided by leaving two or more plants in a hill, with hills a hoe's width apart. On poorer soils larger yields may be obtained usually if three or four stalks are left in a hill.

"Prior to the coming of the boll weevil the fruiting season of the cotton plant was long in most parts of the Cotton Belt, and there was enough time for plants to grow large and utilize much space. It did not matter if the plants were not close together. With time, especially on rich land, they grew large and used all the space available. Under such conditions wide spacing frequently gave good returns. With heavy weevil infestation the fruit must be set in a very short time—say a month or less. This makes it necessary for more plants to be left on the land if all the space is to be used to the best advantage. There is not sufficient time for plants to grow large."

209. NITRIFICATION IN SUDAN SOILS. By F. J. Martin and R. E. Massey (Wellcome Tropical Research Laboratories, Khartoum, Chemical Section. Publication No. 29, 1923.)

"The experiments described in this bulletin were carried out in order to determine the proportion of nitrate commonly present in the soil, the changes in this proportion which take place during the season in fallow and cropped ground, and to deduce from these the most promising method of applying nitrogenous fertilizers.

"The field work was carried out at Shambat, Khartoum North, the agricultural data of which have been given in a previous publication.*

"It may be added that the soil is alkaline in reaction, and is thus favourably constituted for the process of nitrification. The total nitrogen is low, being between 0·012 and 0·025 per cent. in the samples examined. The organic matter in the soil is also low—about 0·5 to 1 per cent.—but during the growth of the cotton crop there is a certain amount of leaf fall which replenishes this in the top layers, and weeds, which are chopped out and left to rot on the surface, also assist in the supply of organic material to the soil.

"*Summary.*—The variations in nitrate content in the plots at Shambat are high, the 'probable variations' being 40 to 60 per cent. of the amount of nitrate.

"The nitrate content of soil samples kept in the laboratory in Khartoum increased on the average about 30 per cent. in four months. During this period the increases in the field from which the samples were taken were much greater.

"Nitrates accumulate on the ridges in irrigated fallow land, but disappear in a dry fallow.

"The division of nitrates in the ridges and furrows is very marked, the nitrates in the ridges being many times greater than in the furrows.

"The division of nitrates between the ridges and subsoil is also marked, the nitrates accumulating at the tops of the ridges; this is not due to evaporation of water from the ridges, since the other salts do not accumulate on the ridges, but in the subsoil.

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* F. J. Martin and R. E. Massey, 1921, "Experiments in Wheat Growing in the Sudan" (Bulletin No. 19, Chemical Section, Wellcome Tropical Research Laboratories, Khartoum).

"The amount of nitrate found in the surface of the ridges is not a proper indication of the amount of nitrate available in the subsoil.

"When ammonium sulphate was applied to cotton at the time of sowing it gave no increase in the crop.

"When applied subsequently, the greatest increase was obtained from applications of manure about two months after sowing, the average increase in one season being 18 per cent. and in the other 14 per cent. for 1 cwt. of ammonium sulphate. When the manure was applied at a later date, smaller increases were obtained.

"Determinations of the amount of nitrate in the soil showed accumulations of nitrates during the growth of the cotton crop. It is suggested that this accumulation (found only in the ridges) does not become available for the crop.

"The flooding of ridges on which nitrate had accumulated, in order to wash the nitrate into the soil, was tried with some success."

210. THE GEOGRAPHICAL DISTRIBUTION OF COTTON. By G. Evans, C.I.E., Director of Cotton Culture, Queensland. (Abstract *Queensl. Agric. Journ.*, May, 1924, pp. 343-351.)

In this paper, which was read before the Royal Geographical Society of Queensland, Mr. Evans divides his subject into three main headings: Production, Manufacture, and Consumption.

Under the first heading the climatic conditions essential to successful cotton production, the most important economic factors, and the damage caused by cotton pests and diseases are discussed. The principal cotton growing countries of the world are enumerated, and a detailed account is given of the chief cotton producing areas of Australia and their possibilities.

Under the headings of Manufacture and Consumption, the author touches briefly on the early history of cotton, and describes more fully its rise in importance in the cotton consuming countries consequent on the introduction of textile machinery. He gives examples of the many new uses to which cotton has been put of late years, and states that the present shortage is in some measure due to this utilization of cotton in so many new industries.

211. RATOON COTTON. (*Queensl. Agric. Journ.*, May, 1924, p. 378.)

We quote the following remarks from the Acting Minister for Agriculture and Stock, Hon. W. Forgan Smith, on the question of Ratoon Cotton:

"In the early stages of the controversy on the Ratoon Cotton Question a promise was made that a test would be carried out on the English markets to secure an impartial report upon ratoon cotton from the English market point of view. On the 9th November, 1923, the S.S. *Leitrim* carried from Brisbane 13 bales of cotton consigned to the Agent-General for Queensland in order to comply with the promise made to the advocates of the practice of ratooning. These 13 bales were made up as follows: (*a*) 10 bales of Upland ratoon lint; (*b*) 2 bales of Durango ratoon lint; (*c*) 1 bale of Annual Durango. As the promise made was to secure an impartial report on ratoon cotton, this consignment was put in the hands of Messrs. A. J. Bustom and Co., a private firm of cotton brokers at Liverpool, which firm is in no way connected with the British Australian Cotton Association, the Empire Cotton Growing Corporation, or the British Cotton Growing Association, and the report from this firm upon this consignment is therefore an unbiassed one, and is interesting as it shows distinctly that the 10 bales of Upland ratoon lint were valued at ¼d. to 1½d. per lb. less than the middling American cotton, which is the standard grade accepted all over the world."

As regards the 2 bales of Durango ratoon, which realized ¾d. to 1¼d. above middling American, the Minister pointed out that this lint was from properly ratooned pure Durango plants, and it was to be expected that the valuation would be at a higher price than the ordinary ratoon.

The bale of Annual Durango which was sent with the consignment was valued at 2d. above the value of middling American, and this valuation shows a marked difference in the values placed on annual and ratoon cotton on the English market.

Mr. Forgan Smith also stated that the Sydney market and the Japanese market were tested some time ago, with the same results in favour of annual cotton.

The results of all these shipments emphasize the desirability of keeping up the quality of Australian cotton to the highest pitch, because it will be realized that it is only by so doing that cotton growing can be made a permanent industry in the State.

212. RATOON COTTON. By S. C. Harland, D.Sc. (*Trop. Agriculture*, vol. i., No. 7, 1924, p. 101.)

A discussion of the subject from a scientific point of view.

213. COTTON CULTURE. By H. W. Taylor. (*Rhodesia Agr. Journ.*, Oct., 1923.)

214. COTTON GRAFTED ON MULBERRY TREE. (*The Field Illustrated*, vol. xxxiii., No. 10, p. 32. New York, 1923. Abstr. from *Internat. Rev. of Sci. and Prac. of Agr.*, vol. i., No. 4, 1924, p. 972. Intl. Inst. of Agric., Rome.)

Nine hundred bolls of cotton are said to have been grown on a plant grafted to a root of a mulberry tree in La Marque (Texas) by Dan George, and to have given exceptional results, said to be at the rate of 4 bales per acre.

Very remarkable if correct, for cotton and mulberry belong to widely separated families, and close relationship is usually necessary for successful grafting.—ED.

MISCELLANEOUS.

215. From the ANNUAL REPORT OF THE IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, SOUTH KENSINGTON, FOR THE YEAR 1923, we quote the following:

"The completion of the Plant Technology building has enabled us to enter into an arrangement with the Empire Cotton Growing Corporation, under which, in return for a grant from the Corporation of £1,000 a year for five years from 1st October, 1923, to be devoted specially to Plant Physiology and Pathology in the Botany Department, the Imperial College is to train a certain number of students with the idea of their ultimately taking up agricultural work in cotton growing countries, and is to assist in research work for cotton specialists abroad, or when on study leave. The Corporation's scheme is designed to increase the supply of raw cotton within the Empire, by the scientific training of the men who will be employed in cotton growing, and by forming a group of specialists at home to whom cotton agriculturists abroad might look for assistance in the solution of their special problems.

"This arrangement has enabled us, *inter alia*, to appoint Mr. W. Brown, D.Sc., as Assistant Professor of Physiological Pathology for the above-mentioned department. It is a matter of no small gratification to us that, along with other institutions which are to receive similar support, the Empire Cotton Growing Corporation should have recognized in this way the valuable developments in Plant Physiology and Pathology which have been taking place at the Imperial College. It is one step further towards the development by research of the Empire's resources."

216. THE ANNUAL REPORT OF THE BRITISH COTTON GROWING ASSOCIATION FOR THE YEAR 1923 (Price 6d.) gives a useful account of the work of the Association.

217. The following Reports have recently been received:

"Annual Report of the Agricultural Department, Nigeria, for the year 1923."
"Annual Report of the Department of Agriculture, Uganda, for the year 1922."
"Report of the Department of Agriculture, Barbados, for the year 1922-23."
"Ministry of Agriculture, Egypt, Cotton Research Board. Third Annual Report, 1922."
"Trade Report for 1923, Sierra Leone."

218. The special cotton growing number of the *International Cotton Bulletin* (No. 8, June, 1924), is indispensable to those concerned with the growing of cotton. It contains, among other useful articles, the replies to a questionnaire sent out by the International Cotton Federation to all countries, except the United States and Egypt, as to areas, yields, methods, kinds of cotton, labour conditions, and the like, and forms an invaluable summary of present conditions.

219. THE THIRD ANNUAL REPORT OF THE COTTON RESEARCH BOARD, EGYPT, 1922.

The Report opens with an interesting article on the Pink Boll-worm, by Mr. C. B. Williams, Senior Entomologist, and continues with abbreviated accounts of the experimental work on cotton carried out during 1922. The programme of work for 1923 is outlined, and summaries of Government and non-Government publications relating to cotton in Egypt are given. The Report is furnished with several appendices dealing with, among other matters, the Egyptian Cotton Crop, Egyptian Climate, Cotton Legislation during 1922, Periodicals and Serial Publications received by the Research Board during 1922, Egyptian moneys, weights and measures.

220. NOTES FROM THE BRUSSELS EXHIBITION OF TROPICAL PRODUCTS. (April, 1924.)

In a paper on the relative advantages of *Cultivation under European management and by native owners* (in general small-owners) in tropical colonies, with special reference to cotton cultivation in the Belgian Congo, M. Lepläe, the Director-General of Agriculture at the Belgian Ministry of Colonies, pointed out that while the former gives a greater yield for area, a better and more uniform quality, and a greater proportion for export, at the same time as it combats disease better and forms a good school for education of the natives, cultivation by the native owners gives the benefits of mass production, renders the people better off socially and more independent, and produces the best work from individuals. Under the circumstances, for the thinly peopled African colonies in which cotton cultivation will probably be mainly carried on in the immediate future, he recommended the diversification of agriculture by the equal encouragement of both systems.*

The Government of such a country is called upon to exert both pressure and persuasion, and must be constantly interfering in agricultural matters by visits of inspectors and otherwise. Cotton, for example, needs three visits a year at least—at sowing time, during growth, and at harvesting. A large staff of trained agronomists is therefore needed, and one of the chief problems in the extension of cotton cultivation is the provision of these men.

In the animated discussion which followed, opinions were expressed in favour of both systems of cultivation, but the general bias was in favour of a combination of the two.—ED. (*Cf.* **226** below).

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* *Cf.* Willis, *Agriculture in the Tropics*, pp. 188, 203.

221. A paper on *Cotton Cultivation in Belgian Congo* was read by M. Maas, who stated that extension is going on with some rapidity, an export of 1,000 tons in 1920 having risen to 3,000 in 1923, while the present year is expected to reach 4,000-4,500 tons, or 16-18,000 bales. The country is proving well suited to cotton, especially in two belts, one north and one south of the equator, which furnish the additional advantage of crops at two different times of the year. The American varieties grown give a staple of 27-28 mm., or say 1⅛ inches, a length well suited to the Belgian mills. About 2 million hectares or 4½ million acres are suited to cotton, so that an output of 600,000 bales is well within the realm of future possibility.

The Government controls all trade, in order to prevent speculation. Cotton markets are established all over the cotton-growing belts, and only ginners can buy the cotton, the price being fixed prior to the holding of the market (in March, for example, it was 50 c. the kilo.). The properly equipped ginnery has a radius of 20 kilometres round it within which no one else may buy or sell, but there is no compulsion to make a man sell to the ginnery within whose radius he may happen to be.—ED.

222. UTILIZATION OF PIMA COTTON. By Horace H. Willis. (*U.S. Dept. Agr.*, Bull. No. 1184. Nov., 1923. Gov. Print. Off., Washington, D.C.)

223. THE PART THE SHIPPER PLAYS. By A. N. Monkhouse. (*Manchester Guardian Commercial. Textile Finishing Trades*, May 15, 1924, p. 714.)

224. SOME THOUGHTS ON LANCASHIRE V. AMERICA. Anon. (*The Textile Recorder*, June 14, 1924, p. 66.)

225. RESEARCH IN THE COTTON INDUSTRY. By Dr. J. C. Withers. (*Manchester Guardian Commercial. Textile Finishing Trades*, May 15, 1924, p. 716.)

226. The question of cotton growing by natives is proving of very great interest in many parts of Africa. We learn from the *Sunday Times*, Johannesburg, that many white settlers are strongly averse to the policy of attempting to induce natives to grow cotton, the reason given for this opposition being that the latter's primitive mode of living, lack of education and ambition, and absence of any thought for the morrow precludes any hope that he will become an efficient and consistent cultivator of cotton in large quantities. The native, according to them, will grow cotton only when prices are high or food scarce, but when prices are low, or food is plentiful, he will abandon his cotton patches all over the country, and these will prove extensive breeding-grounds for cotton pests, with the consequent result of a serious setback to the industry from which it may never recover.

From a further source we learn that another reason for the opposition of the white settlers is that the labour situation in most parts of Africa is already very acute, and if the amount of native labour available for employment is still further reduced by the native growing cotton on his own small-holding, the white farmer will be seriously handicapped in his efforts to increase the raw cotton supplies of the Empire. (*Cf.* **220** above.)

227. PUBLICATIONS. *Cotton and Other Vegetable Fibres; their Production and Utilisation.* By Ernest Goulding, D.Sc., F.I.C., Scientific and Technical Department, Imperial Institute. (See *Imperial Institute Bulletin*, vol. xxi., No. 1, 1923, pp. 14, 111, 280.)

Modern Cotton Economics, 1923. By T. Thornley.

Recent Soil Researches and their Application to Practical Agriculture. By N. Kunjan Pillai, M.A., B.Sc., Ph.D., Director of Agriculture, Travancore.

The Hydrogen-ion Concentration of Heavy Alkaline Soils. By A. F. Joseph and F. J. Martin. (From the *Journal of Agricultural Science*, vol. xiii., part 3., July, 1923.)

MISCELLANEOUS NOTES

It is with much regret that we have to announce that Lord ASHFIELD has been compelled to resign his position as one of the Vice-Presidents of the Corporation owing to pressure of other work.

We have pleasure in announcing that Sir GEORGE LLOYD, G.C.I.E., G.C.S.I., late Governor of Bombay, has accepted appointment as a Vice-President of the Corporation.

APPOINTMENTS.

Dr. H. MARTIN LEAKE has been appointed Principal of the Imperial College of Tropical Agriculture, Trinidad, in succession to Sir Francis Watts, retired.

STUDENTSHIPS.

The following have been elected to Studentships under the Corporation for the year 1924-25. They will hold their studentships at the place named in the second column:

SENIORS.

Name.	*Studentship Tenable at*
J. V. R. Brown	Cambridge.
J. W. Cowland	Trinidad.
J. B. Hutchinson	Trinidad.
O. B. Lean	Nigeria.
W. C. Lester-Smith	Trinidad.
H. Marsland	Trinidad.
F. S. Parsons	Trinidad.
J. E. Peat	Trinidad.
C. H. Richards	S.E. Agr. Coll., Wye.

JUNIORS.

E. R. Guest	S.E. Agr. Coll., Wye.
J. C. Haigh	Imp. Coll. of Science and Technology.
F. E. Kenchington	Cambridge.
H. G. Miller	Cambridge.
E. P. Mumford	Cambridge.
J. L. Schofield	Cambridge.
E. H. G. Smith	Cambridge.

Of those elected to Studentships last year, four men have been appointed by the Corporation to posts as supernumerary officers attached to the Agricultural Department of the Government of Uganda. If their work is satisfactory they will be given the option of transferring to the permanent staff of the Agricultural Department as and when vacancies occur. A fifth man has been appointed by the Agricultural Department of Uganda to a vacancy on its staff, while a sixth has been appointed as Cotton Botanist, and a seventh as Government Agricultural Chemist in the same Protectorate.

OFFICERS ON LEAVE.

When an officer of a colonial Department of Agriculture (or of the allied departments of Irrigation, Transport, etc.) comes " home " on leave, he usually brings with him much information that may be of considerable value to similar officers in other colonies, or to the officers of the Empire Cotton Growing Corporation, who have to collect, collate, and use all possible information relating to cotton, The Corporation would consequently much appreciate the courtesy if Directors of Agriculture and others would be so kind as to inform them, in advance if possible, of the names, probable addresses, and approximate dates of arrival in England of officers coming on leave. This would give the Corporation the opportunity of getting into touch with these officers themselves, and of giving the latter the opportunity of meeting with one another. A further courtesy would be conferred if the officers themselves, upon arrival, would call at, or inform, the offices of the Empire Cotton Growing Corporation, which are at the corner of Millbank and Wood Street (entrance by the first door in Wood Street) immediately opposite to the offices of the Crown Agents for the Colonies.

At the date of writing the following officers are on leave in England:

Bermuda	Mr. E. A. McCallum.
British Guiana	Mr. W. Francis.
Ceylon	Mr. F. A. Stockdale.
Gold Coast	Mr. W. S. D. Tudhope.
,,	Mr. T. Hunter.
,,	Mr. J. Steele.
,,	Mr. M. D. Reece.
Iraq	Mr. R. Thomas.
Jamaica	Mr. G. H. Deerr.
Kenya	Mr. A. Holm.
Malay States	Mr. D. H. Grist.
,, ,,	Major B. J. Eaton, O.B.E.
,, ,,	Mr. G. H. Corbett.
Nigeria	Mr. F. J. Evans.
,,	Mr. C. J. Lewin.
Nyasaland	Mr. E. J. Wortley.
Rhodesia (Southern)	Mr. W. H. Taylor.
Sierra Leone	Mr. M. T. Dawe.
Tanganyika	Mr. A. H. Kirby.
Tobago	Capt. R. J. Link.
Trinidad	Mr. W. M. Nowell.
Uganda	Mr. T. D. Maitland.

Mr. B. C. Burt, Secretary of the Indian Central Cotton Committee, is still on leave in this country.

Mr. H. C. Sampson, the Corporation's Cotton Specialist in Nyasaland, is also on leave in England.

SPINNING TESTS.

Directors of Agriculture who avail themselves of the Corporation's offer to have spinning tests carried out on samples forwarded to these offices, are specially requested to see that a specification indicating the country of origin of the sample, and the type of cotton, is included *inside* each bag, since labels on the outside are frequently damaged or torn so as to become illegible.

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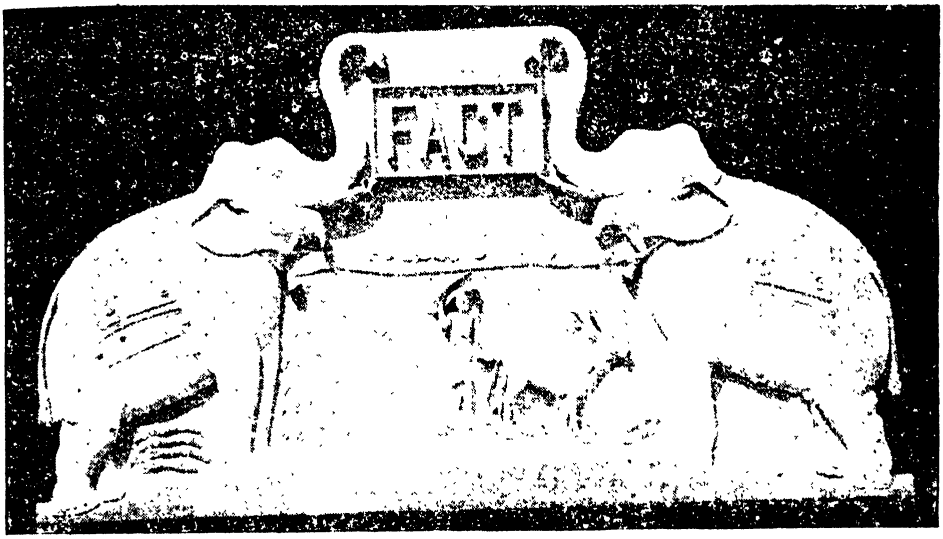

VOL. 2 | MAY 1918 | No. 8

EDITORIAL

THE ROYAL VISIT.

THE twentysecond of April Nineteen-hundred and forty-eight was a red-letter day in the annals of FACT. For on that day H. H. The Maharaja of Travancore along with the Hon'ble the Ministers of State paid a visit to our factory.

Under a decorated pandal erected at the entrance to the factory His Highness and party were received by Rajyasevanirata S. Chattanatha Karayalar, Mr. Seshasayee and Dr. K. P. P. Menon and were led to the visitors' room where a model of the factory helped to give to the distinguished guests an overall topographical view of our institution. His Highness and party were then taken round the extensive factory premises stage by stage and the working of the various plants and machinery units – from the producer Gas section to the Ammonium Sulphate works – was clearly explained to them With intense interest and insight, His Highness asked several questions to the persons who were in charge of the different works and appeared to be pleased with the way in which things were being done. The Ministers too, particularly Mr. C. Kesavan, showed great interest in understanding the detailed working of the plants.

After the inspection of the Chemical Laboratory, the Hydrogen plant, the Nitrogen plant, the Ammonia Synthesis plant, the Ammonium Sulphate plant, the Sulphuric acid plant, the workshop and the landing wharf, His Highness and party motored to the hall in the Administrative Block, where various charts, graphs and statistical diagrams indicating at a glance the necessity for, and the value of, the fertilisers in increasing the productive capacity of the soil had been exhibited. Mr. C. S. V. Ramani explained to the guests the various statistical charts. Rajyasevanirata Chattanatha Karayalar on behalf of FACT presented His Highness a Souvenir which His Highness graciously accepted. The Souvenir consisted of a small ebon elephant holding horizontally with its trunk a transparent glass tube containing crystals of Ammonium Sulphate produced in FACT. His Highness expressed appreciation of what he saw and congratulated Mr. Seshasayee on the success so far achieved by FACT.

It was, indeed, a great occasion for FACT. We have had many distinguished visitors before. But it is not merely a sense of duty, nor even a sense of patriotism that bids us aver that no other visit by great personalities has bucked us up so much as this visit of our Beloved Maharaja and his trusted Ministers of State. For they have, in common with us, an identity of interest to see that Travancore becomes self-sufficient in the matter of food, in the quickest possible time. And the present visit has upheld and sustained this common interest in an abundant measure. We trust that His Highness and the Ministers will continue to encourage us by similar visits and extend their patronage to the country's Premier Industrial Enterprise, which in common parlance is FACT, and which has become an established FACT.

Other Distinguished Visitors.

On the 25th of this month Mr. Jairamdas Daulatram, Dominion Food Minister, accompanied by Dr. T. S. S. Rajan, Food Minister, Madras Government, Mr. V. Hejmadi, Commissioner for Civil Supplies and Mr. B. R. Patel, Joint Secretary, Food Ministry, now touring deficit areas in South India, visited the factory. Mr. H. Sitarama Reddy, Minister of Industries, Government of Madras, Mr. T. M. Verghese, Minister of Industries, Travancore Government, and Mr. K. G. Menon, Development Secretary, Madras, also accompanied the Dominion Minister.

On behalf of the Managing Agents of FACT, Mr. V. Seshasayee received the Ministerial party at the Cochin Air Port, whence they motored to Alwaye.

At the factory they were taken round the premises and the working of the several plants and machinery units—from the Producer Gas Section to the Ammonium Sulphate Plant—clearly explained to them. The Workshop and the Superphosphate Plant were next inspected.

At a meeting held in the Cafeteria building, Mr. V. Seshasayee paid a tribute to the Dominion Minister on his work for relieving the anxieties of the people of this part of the country, particularly on the Food front.

Mr. Seshasayee's speech and the Food Minister's reply are given in this issue.

Mr. T. M. Verghese, our popular Minister of Industries in a felicitous speech thanked the honoured guest, on behalf of the people of Travancore, as well as our Government and the Company's Management He also emphasised the need for full co-operation on all sides to make this unique enterprise a signal success.

Speech by the Hon'ble Sri Jairamdas Daulatram

at The F. A. C. T. Ltd. on 25-5-1948.

My dear fellow countrymen,

AS you can make out from the manner in which I have addressed you, I wish to look upon you not as those individuals who are working in this factory to produce certain fertilisers. I wish to look upon you as those who are working to make your country prosperous. Do not look upon your work as merely industrial or chemical. Look upon your work as National. I do not want to go into a discussion as to how far chemical fertilisers should be used, in what manner they should be used, and to what extent they should be used. But, there can be no doubt that the country at present is wanting more and more of fertilisers. Therefore I would request you all, young men, to consider yourselves as the builders of the India of tomorrow.

It lies in your hands to work with the greatest possible capacity, ability, expedition and produce fertilisers, the best quality and in the speediest time, To the extent that you do this you may be well deserving your wages, your salaries or your allowances; but look upon the result as a mere accident. Everybody who gives his time and energy for any productive work deserves remuneration. But that is a matter of mere accident, as casual result. The main objective before you ought to be "I am so circumstanced, I am in such a position that by doing my duty better I am able to help my country forward." If you look upon your work in this factory in that light then I will say that you will be doing your duty to the country.

When I am looking at you, I find before myself intelligent men, energetic men with some spirit and fire in the eye. And, therefore, my expectations of you are only the higher. Produce whether chemicals this factory is intended to produce; but throughout work with that spirit, work with that motive, work with that objective which I intended by addressing you as "my dear fellow countrymen."

India has vast tasks before it, at the same time, India, at present, is faced with vast difficulties and the same courage and determination which kept us afloat during the last 30 years in spite of all manner of opposition, that same determination and courage should enable us to go through the coming constructive period and rebuild a happy and prosperous India.

I fully realise that but for the co-operation of American skill and Indian industry and the co-operation of the three Governments and also that of Mr. Seshasayee and his collaborators, what has been achieved in a year and a half could never have been achieved. I congratulate all those who are responsible for this quick result. Probably, this is one of the few cases in which big tasks have been achieved in a very brief time. To all those who have contributed to this, I give my respectful congratulations and, as I said, the country looks upon you, young men working in this institution, apparently manufacturing a "dear" article, apparently working for your wages and salary, the country expects from you that you will do all that in the true spirit and that spirit is the service of a future prosperous and happy India.

Full text of the Speech of Mr. Seshasayee

25 - 5 - 1948

Sir,

ON behalf of the Chairman, the Directors, management and staff of FACT, I have great pleasure in welcoming you, here, today.

About this time, a year ago, Dr. Rajendra Prasad, your predecessor in office, did us the honour of visiting this factory, and it is now our good fortune to have another distinguished Food Member spending a little time with us.

As the Hon'ble Dr. T. S. S. Rajan, Food Minister for Madras, would bear me out, we, in Soth India, have particular reason to be grateful to you, for right from the time you assumed office, you have done a good deal for relieving our anxieties on the Food front.

As though the gods themselves endorsed your assistance to us — synchronising with your tour of this part of the country — comes the news of a further allotment of rice to India by the Rice Committee of the International Emergency Food Council.

In welcoming you to this factory now, I should like to mention how a visit such as yours – apart from the fine compliment inherent in it – makes for a livelier appreciation on our part, of the responsibilities on which we are engaged.

And you too, Sir, perhaps be disposed to show us even greater consideration after an original, 'first-hand impression.

About four years ago when I approached the Dewan of Travancore with the scheme, he was kind enough to assure me of his support and encouragement to it. Sri N. Gopalaswami Ayyangar was then requested to be the chairman of the Board to which, with his usual kindness, he readily gave his consent. Starting under favourable auspices, with promise of assistance by the Travancore Government and with a Board headed by Sri Gopalaswamy Ayyangar the success of the venture was a matter of course. Later, the Madras and Cochin Governments also began to participate so that in the overall arrangement there was partnership between one Provincial and two State Governments, leaving at the same time scope for private initiative and enterprise. The combination of all these was necessary to bring the factory to its present stage of completion within this short period. Although three Governments are involved and the Management is in private hands, and, notwithstanding the fact that all the three Governments have been actively participating in the affairs of the company, I am happy to be able to say that relations have always been perfectly cordial. There has been complete unanimity in all the important decisions reached.

The Travancore Government bore the brunt of the responsibility and they have invested one crore and twelve-and-half lakhs of rupees in shares, Rs. 95 lakhs as loan, Rs. 5 lakhs by way of land and Rs. 6 lakhs in the shape of electrical equipment. Thus, out of the total investment of over Rs. 3·5 crores, nearly Rs 220 lakhs have been contributed by the Travancore Government.

FACT was conceived at about the same time as the Government of India project at Sindhri and although the rated capacity of our plant is only one-seventh of the other—50,000 tons of ammonium sulphate per annum—it is at the moment the biggest fertiliser enterprise in the country.

Designed, equipped, erected and run in record time, we may be pardoned for being a little proud of our achievement. Still in its tuning-up stage, the factory has already produced and sold a quantity of approximately 11,000 tons of ammonium sulphate.

As mentioned already, the plant is designed for a normal output of 50,000 tons of sulphate of ammonia per annum. This quantity will cover the fertiliser requirements of 1·25 million acres and is calculated to increase rice production by 6½ lakhs of tons a year. We have already started manufacture of superphosphate and we estimate to produce 25,000 tons during the year from July onwards. The ultimate capacity of the superphosphate plant will be nearly one lakh of tons.

Our primary object in establishing this factory has been to enable the country to stave off food shortages and famines by increased production, and to make it as selfsufficient as possible in the matter of its food requirements.

While during peace time this factory would serve in producing fertilisers for food production and basic chemicals required for numerous other industries, in times of war, the equipments can, almost overnight, be switched over for producing explosives; just as steel is common both to the sword and the ploughshare, nitrogen is a vital necessity both for plant and animal life and explosives and, we are equipped to collect that from Nature and to tame it for use according to our needs.

The processes and equipments have been specially designed for utilising raw materials locally available. The main requirements of the factory are wood, gypsum, electric power and water all of which are available locally. We are now using fuel oil and sulphur imported from foreign countries. But when a period of emergency arises, we can do without this. Fuel oil can be replaced by coal or even firewood and sulphur by gypsum.

The industry requires very great technical skill and experience. Our countrymen are rising equal to the occasion and are already manning the plant with great satisfaction. I do not however say this with a view to belittling the debt we owe to our American friends and technicians who have helped and are helping us to run the factory successfully. It is a rare opportunity for the Asst. Superintendents, foremen and other operating personnel who have been chosen for the task, to deserve the trust that is placed in them and I am very glad and proud they are discharging their functions with that great sense of conscientious concentration and responsibility that is necessary to operate the plant successfully.

Hereafter, it is up to you and the other Hon'ble Ministers Sir, to enable us to continue to serve you and, through you, the country.

I thank you once again for the great trouble you, the Hon'ble Dr. Rajan and others have taken in visiting us and I hope that you will be carrying with you pleasant memories of your visit to us

Some Special Features of our Gas Plants

BY MR. H. HOWE.
(Technical representative of The Power-Gas Corporation Ltd)

IT is of course now well known that our fertiliser factory here at Alwaye is the first in the world to produce ammonia synthesis gases using wood, a natural resource of the State, as the raw material. In consequence, we are in the nature of pioneers in the building up of such an industry from our own indigenous resources and, although the several individual sections have been fully proven in other industries for many years past, several original features have been incorporated in linking them together in this new venture to form a complete synthesis gas production section. This section is also unique in the fertiliser industry in that practically pure nitrogen and hydrogen are separately produced and sent forward to the ammonia synthesis plant. By this means the synthesis gas mixture is under practically perfect control and its composition is readily capable of precise adjustment to the exact needs of the ammonia synthesis plant.

The synthesis gas plant comprises four main sections: the producer gas plant; the hydrogen generating plant; the nitrogen plant and the high pressure purification plant.

The first section, the producer gas plant, can conveniently be subdivided into wood handling, gas production and gas purification.

The wood handling plant had to be capable of handling, by mechanical means, approximately 300 tons of natural wood each 24 hours and distributing it to five producers. For satisfactory operation of the producer plant the pieces require to be approximately 12″ dia. by 18″ long and some 8,000 to 10,000 such pieces, of somewhat varying girth and shape, have to be handled each 24 hours. The small logs as they come from the forest are mechanically fed through a set of circular saws and thence by chain and drag link conveyor to the wood store. Other similar conveyors along the length of the wood store feed the cut pieces to an inclined conveyor which discharges into distributing chutes at the top of the producer plant building. The hard woods cause heavy wear and tear on the circular saws and sharpening is necessary at regular and frequent intervals.

The gasification section comprises six gas producers each twelve feet inside diameter, the largest ever built for using wood. Moreover, as distinct from the usual wood-fired gas producer, the plant is designed to produce not a gaseous fuel but a combination of gases suitable for the subsequent chemical reactions. In other words, it is a chemical plant and not a mere gas making plant.

The wood is fed into top hoppers, the top and bottom doors of which are six feet in diameter. Since these doors must be gas-tight and yet easy to operate, careful design and balancing is necessary, particularly to minimise unbalance in operation which might cause them to swing in such a manner as to damage the equipment. The bottom doors are further fitted with pneumatic dampers to slow their movement as they approach the fully open position. Interlocks are also provided between the top and bottom doors to prevent the one inadvertently being opened before the other has been closed, thereby to avoid possible gassing of the operators or accidental loss of gas.

In order to promote uniformity of gas quality and quantity a distributor is placed between the bottom door of the feed hoppers and the top of the fuel bed in the producers which ensures the even distribution of the wood blocks and provides a supply of green fuel to feed down by gravity and maintain the level of the fuel bed when the latter tends to fall. Also, the producers are placed over water seals to allow the removal of ash whilst the plant is under load and without interruption in gas making.

The producers are deep to provide a deep fuel bed capable of giving the high percentage of combustible gases which are needed for the production of hydrogen and to produce a tar of a consistency which can be used for valuable bye-products. Additionally, steam connections are provided to add steam to the blast as required, to ensure continuity of gas quality in the various seasons. For example, in India, the moisture content of the wood can vary considerably from about 45% during the monsoon period to 15% in the dry season and a humidified blast may be required in the latter case to enable the percentage of reducing gases in the producer gas to be kept reasonably constant.

The gas purification section removes carbon dust, about 2,500 gallons per day of tar, acetic acid and water vapour from the raw gas issuing from the producers. It is effected in two stages firstly the gas is shock cooled and washed with large quantities of chemically treated and recirculated water which neutralises the acetic acid and removes the heavy tar and dust. Sulphur gases are partially removed from the gas in this washing process. The cooled, partially cleaned gas then passes on to an electrostatic detarring plant where it passes through a high voltage field. The tar particles receive a charge which causes them to be thrown on to tube surfaces where they run down to a tar-collecting system. The clean gas is then boosted before passing on to a storage gasholder. As far as is known, this is the first time that electrostatic means have been adopted for the cleaning of a producer gas made from wood logs. All the necessary tar handling plant is included in the installation. The water, which becomes heated in cooling the gas, is cooled by means of a forced draught water-cooling tower before recirculation to the plant and in this cooling process a chemical action partially revivifies the solution. A chemical dosing plant completes the installation.

A feature of the plant is the instrumentation which is greater than usually found on mere producer gas plants. This permits of the careful control of gas quality and quantity, cleanliness, temperature and pressure necessary for such a chemical plant.

Adequate spare plant has been provided to ensure continuity of operation with due regard for keeping the capital cost as low as possible.

The hydrogen generating plant utilises the steam-iron process for the production of hydrogen from steam whereby an incandescent iron ore is alternately reduced with producer gas to a lower oxide and subsequently oxidised by superheated steam, the latter being split into its components, oxygen and hydrogen, the oxygen uniting with the iron and oxides to form the higher oxides again and the hydrogen being liberated.

The process is therefore a cyclic one and, to ensure hydrogen production of uniform quality and at constant efficiency, automatic controllers are provided for each generator to operate the various valves in the correct and timely sequence. Interlocks are incorporated to prevent a dangerous mal-sequence or combination of valve operation, a necessary precaution where large volumes of hydrogen are produced.

The hydrogen generators are the largest ever built, being twelve feet inside diameter and, being ten in number, make the largest steam-iron hydrogen installation in the world. From the 24 hydrogen stations built in the United Kingdom during the war to provide hydrogen for the balloon barrage defence, 20 of which were in operation at any one time, the maximum output was approximately 2·5 million cubic feet per day, whereas with 8 out of the 10 F. A. C. T. hydrogen generators in operation, the nominal output is 3 million cubic feet per day.

Waste heat boilers are installed to recover much of the heat from the waste gases, i. e. the spent reducing gas. Only the large output of the plant made their adoption economical and on small units their capital cost would offset the saving in operational costs. Gas preheaters are also provided on a bypass system to take some of the hot spent gases and utilise their sensible heat for preheating the producer gas entering the generators, thereby improving the efficiency by decreasing the amount of reducing gases required and hence the amount of wood consumed.

The adverse action of sulphur gases on the ammonia catalyst and on the solution used for the high pressure purification plant involves the use of the wet purification system wherein the hydrogen is washed with a weak chemical solution which is constantly revivified over an air blown water cooling tower. The hydrogen then passes to a storage gasholder, and from thence to the ammonia synthesis plant.

Each individual hydrogen generator is fitted with its own panel of instrument and each bank of five has an instrument panel so as to give the extremely accurate control of temperature, pressure, rate of flow etc., which is so important in the maintenance of the constant production of quality and quantity of synthesis gases which the rest of the process requires

The nitrogen plant provides another example of our pioneering work resulting from our decision to use the indigenous resources of the State. Whilst nitrogen for ammonia synthesis gas has often been provided directly from producer gas made from coke and on occasions from the combustion of hydrogen, we have no knowledge of it having been provided before from the combustion of producer gas. The use of a volatile fuel for the producer gas generation, and the consequent presence of a fair percentage of methane in the gas, made the direct use of this producer gas impracticable at Alwaye. Furthermore the high carbon monoxide content would have meant the use of a carbon monoxide conversion plant. By burning producer gas several advantages accrue: firstly the amount of wood consumed per unit of nitrogen is reduced by reason of the nitrogen collected from the burning air; secondly the carbon dioxide required in the sulphate plant is provided, and thirdly by arranging the combustion in a boiler, valuable steam is generated. Furthermore, the use of gaseous fuel for the production of nitrogen makes possible very accurate control of combustion, and automatic pressure control is installed to prevent the upset of combustion conditions as either excess oxygen or carbon monoxide are undesirable.

All the undesirable contents of the producer gas are burned or changed in such a way that they are capable of removal in the carbon dioxide removal plant, which latter embodies the well known Girbitol system wherein the gases are washed with a chemical solution and the purified nitrogen then passes to a storage holder The chemical solution is later regenerated (by heat treatment) and recirculated through the system. In this regeneration process the carbon dioxide and the sulphur gases which have been absorbed are driven off and the carbon dioxide is collected and passed to the sulphate plant. Since insufficient carbon dioxide for the sulphate plant is produced from the nitrogen process alone, the spent gases from the hydrogen plant, which contain over 20% of this gas are passed to a second Girbitol absorption system. This has been installed to give capacity greater than the balance required for the sulphate plant in order to provide an excess supply of the gas which can be liquified for mineral water manufacture etc, or solidified to provide a refrigeration medium. A common regeneration system has been provided for both absorption systems giving simplification of control with a saving of both capital and operating costs.

The nitrogen and CO_2 recovery plants are extensively instrumented to provide continuity of quality products under any load conditions.

It is believed that this is the first time the Girbitol system has been used to provide simultaneously both a pure nitrogen and a bye product carbon dioxide, the usual industrial use being to separate and collect one of these gases only and eliminate the other as a waste product.

The high pressure purification treates the nitrogen and hydrogen, now mixed in the desired proportions for synthesis, for removal of carbon monoxide and final traces of carbon dioxide, which purification is effected at about 2,000 lbs. per square inch pressure, i e at an intermediate stage of their compression to the required synthesis pressure. They are first washed with a copper ammonium solution for the removal of carbon monoxide and then with an alkaline solution for the final removal of carbon dioxide. Here the former is removed down to about 10 parts per million and the latter to less than one part per million.

A feature of this unpurified mixed synthesis gas is the very low percentage of carbon monoxide present. In most production systems it would be of the order of three percent, necessitating the installation of a much more costly high pressure purification plant than with the purer gas made here at Alwaye.

The new venture of linking together each individual tried and proven section to form a complete synthesis gases plant, and the particular climatic, labour and transport conditions obtaining at site, especially in a previously non-industrial region, presented to the Engineers difficulties in design which could not always be solved by reference to past experience. The contractors have had considerable experience in plant installations in practically every part of the world and, as a result, these difficulties have been overcome with a minimum of delay and inconvenience.

In order to undertake work of this nature a large and competent engineering and design staff is essential, employing men of both practical experience and high academic qualifications It may be of interest to readers to know that the Contractors for the gas producing equipment described herein, have applied for and carry at the present time, some seventy patents in the field of chemical engineering and these are embodied to a large extent in many of the specialities at Alwaye.

Cold Treatment

If you don't treat a cold it will last for 14 days.
But if you do treat it, it will last only for a fortnight.

MANURING OF TEA

BY

W. W. MAYNE, B. Sc., Scientific Officer,
THE KANNAN DEVAN HILLS PRODUCE CO. LTD., MUNNAR.

THE use of fertilizers, in the limited sense of products of chemical industry or mining, in tea is of comparatively recent origin. Writing in 1903, Dr. Watt and Dr. Mann said "We cannot consider that at present they can have, except as regards phosphates, any but a very subsidiary position in the Indian Tea Districts". In Ceylon, where tea has probably been the largest consumer of imported commercial manures and fertilisers, the total annual imports of inorganic nitrogen fertilisers before the 1914—18 War were considerably less than 2500 tons and organic manures (Castor Cake, Groundnut Cake etc.) accounted for between 80% and 90% of the imported supplies of nitrogen. By 1928, however, over 50% of the imported supplies of nitrogen were in the form of Sulphate of Ammonia, Nitrate of Soda, Nitrate of Potash and Calcium Cyanamide, and the total consumption of nitrogen in such fertilisers was seven times as great as in 1913, and the tendency has continued up to the present. In fact during recent years supplies of the organic manures from external sources to that island have been cut to a very low level by the prohibition of exports of most such manures from India, the main source of supply.

In India, the trend has been similar, but owing to the greater variety of crops using fertilisers and manures, data are not very easy to extract. However, the Indian Tea Association estimated the 1947 requirements of Sulphate of Ammonia for the North Indian tea areas, representing about 80% of India's production at about 35,000 tons. Calculating on the same basis, South India's requirements for tea would be about 8,000 tons, although so far nothing like this quantity has ever been used.

It was not until the decade 1920—30 that the manuring of tea began to be placed on a scientific basis, first as a result of the investigations at Tocklai in Assam and later at St. Coombs in Ceylon. Scientific work on this question in South India began much later, but has so far completely confirmed the work done elsewhere. The increasing use of artificial fertilisers coincided roughly with the intensification of research into the manuring of tea, but was also influenced by the cheapness, low freight cost per pound of nitrogen and relative abundance of supplies which followed on the development of the direct fixation of atmospheric nitrogen during and after the 1914-18 War.

The increased use of artificial fertilisers was checked by the period of crop and export restriction between 1933 and 1939 and to some extent by the wide-spread reaction against such fertilisers associated with the late Sir Albert Howard's advocacy of compost manufacture. The existing demand for tea which, for the moment, exceeds the supply has increased substantially the demand for fertilisers which of course can only be partially met owing to the general world shortages of fertilisers of all kinds.

It is obvious that this demand would not have arisen unless the economic returns were definite and substantial. There are, in fact, few crops in which the relation between the use of fertilisers and crop yield is so clear and the results of research at widely separated points in the geographical range of production, so uniform.

These results of research indicate that nitrogen is by far the most important constituent required to raise the crop level of the tea bush, and that the actual source of nitrogen among the usual commercial, manures and fertilisers is of lesser importance. In North India, the results indicate that Sulphate of Ammonia is the most efficient form of nitrogen fertiliser. Writing in 1946, Mr. Cooper of the Tocklai Experimental Station, Assam, says "We find therefore that Sulphate of Ammonia is the best form in which nitrogen can be applied to tea, and so long as it remains also the cheapest form, no other can be advised". Experiments in South India and Ceylon show little or no difference in effectiveness between Sulphate of Ammonia and Groundnut Cake applied at equivalent quantities of nitrogen, but the former is usually cheaper to buy and always cheaper to transport, for a given quantity of nitrogen.

The well-known effect of Sulphate of Ammonia in increasing soil acidity, which is sometimes a draw back to its regular use with some crops, is of small importance to tea which prefers soils of a high degree of acidity.

The actual increase of crop obtained per lb of nitrogen applied varies but the general results of experiments show a return of between 4 and 8 lbs. of made tea per lb. of nitrogen. A series of experiments on 15 different estates in N. E. India gave an average crop increase of about 4 lbs. of tea per lb. of nitrogen applied, the lowest being 1·2 lbs. and the highest 9.2 lbs. One experiment in South India gave the following crop increases per pound of nitrogen added:—

Dose applied	40 lbs. Nitrogen.	80 lbs. Nitrogen.
I. 1st year after pruning	1. 97 lbs.	1. 92 lbs.
2nd. „ „	3. 79 „	4. 57 „
3rd. „ „	2. 12 „	4. 24 „
II. Pruned.		
1st. year after pruning	2. 55 lbs.	3. 38 lbs.
2nd. „ „	7. 15 „	8. 94 „
3rd. „ „	3. 90 „	6. 60 „

These figures illustrate three interesting points. The first is that up to 80 lbs. of nitrogen per acre, the Law of Diminishing Returns has not set in, in fact the higher quantity of nitrogen has given a more efficient response than the lower. The second is that the effects of the fertiliser during the cycle between one pruning and the next are better in the second year than in either the first or the third, but that the effect in the third year is markedly more efficient with the higher dose than with the lower. The third is that the effects are cumulative, during the period covered by the experiment; with continued application the efficiency of the crop response increases.

Actual results of commercial applications on a large scale over a period of years are difficult to secure and interpret, but there is no question that increases averaging 4 lbs. of tea for every pound of nitrogen added are being obtained in commercial practice.* It has been found, however, that where tea is grown under heavy stands of shade, the responses are less and may sometimes not occur at all. The best results from fertilisers are undoubtedly obtained on unshaded or lightly shaded tea, but the question of the relation between shade and manuring requires further investigation.

To discuss this problem with reference to actual production, it can be said that a reasonably good and well managed tea estate in South India can be expected to average about 600 lbs. per acre without fertiliser, apart from losses which may occur from the newly arrived disease, Blister Blight. A dressing of 60 lbs of nitrogen in the form of 300 lbs. Sulphate of Ammonia can be expected to raise this level to between 800 and 900 lbs. per acre, though this cannot be expected immediately after the first application.

It is not generally considered sound agricultural practice to manure only with one of the three principal plant food materials derived from the soil, but the evidence so far available does not indicate that the other materials--Phosphoric acid and Potash-make any appreciable difference to production when applied in the form of fertilisers. There is some evidence both from Ceylon and South India that additions of phosphate may be desirable at high levels of nitrogen manuring and from Ceylon that plots manured with nitrogen for twelve years, in the absence of potash, were beginning to show some signs of a need for this manure. It would seem, however, that the use of nitrogen fertilisers alone can be continued for a considerable time with profit and without harm to the soil or the tea bush. Nevertheless, it is probably desirable to begin including small quantities of sources of phosphate and potash in fertiliser mixtures after 6-10 years.

If all the tea in South India were to receive a reasonable dressing of nitrogen-say 40 lbs. per acre-of Sulphate of Ammonia it would require about 14,000 tons per annum. Even if every allowance is made for heavily shaded areas, the use of other sources of nitrogen, poor tea not worth manuring and indifferent individual producers, it would seem that the South Indian tea industry should be able to consume some 6000 to 8000 tons per annum, provided, of course that the relative prices of Sulphate of Ammonia and tea did not alter appreciably for the worse.

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*It is noteworthy that 5 lb of ammonium sulphate gives on an average an increase in yield of more than 4 lbs. of tea, the money value of which is at least ten times that of the value of the fertiliser used..........................Editor.

AGRICULTURE IN ANCIENT TAMILNAD

By

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(Retired Secretary to the Govt. of Cochin)

WHEN first Tamilnad--which was how the extreme south of India, including Kerala was known to the ancients—emerges from the mists of legend into the light of authentic history, it was peopled by the Tamils, who were the proud possessors of a civilisation which equalled, if not surpassed the best that then existed on this inhabited world. The early Tamils divided arts into six groups; ploughing (meaning thereby agriculture), handicrafts, painting, commerce and trade, the learned arts and lastly the fine arts. Very high place was given to agriculture. The Tamil word for agriculture was Vellaima reproduced in Vellalan, the caste whose occupation was pre-eminently agriculture. The Malayalam word still in current use in the eastern parts of Kerala is also Vellaima or Vellama and there is also a caste among the Nairs called the Vellaima Nair, meaning in all probability the caste whose hereditary occupation is agriculture and considered in some parts of Kerala to be the highest among the various sub-divisions of the Nair Caste. The Tamil classics, like Silappadikaram, Kamba Ramayanam etc., both of the Pre-Christian Era and the period after Christ bear witness to the high level of excellence of agriculture attained by the early Tamils. They give a wonderful account of the life of the ancient Tamils in all its various phases. The husbandmen were regarded as a class sacred and inviolable and their daily lives from morning till evening with their agricultural implements, the songs they sang while harvesting the fields or threshing the sheaves of corn, or pounding the paddy and the festivals which followed the harvesting, are all described in these books with a minuteness of detail and a deftness of touch which are truly marvellous. Cultivation was mostly communal and the power of men in combination was seen at its best in the field of agriculture in the absence of machinery which replaces human labour in many directions.

One of the many beautiful songs which were sung by field labourers on the threstirg floor of paddy fields, was known as Ermangalom (Er—cattle used for ploughing and sometimes cultivation itself; and mangalom—prosperity). The name of the song still lingers in the place-name Eraimangalom which appears to be a variant of Ermangalom. The Silappadikaram speaks of Télvili, a raga in frequent use in the music of the village maidens; and kinai, the village drum used to call villagers together in times of common distress. Communal Cultivation of water-logged areas was very much in vogue. This was something analagous to what is now known as Kole cultivation in Malabar. Paddy is raised by bailing out water from water-logged areas not with the aid of oil engines as now but by crude contrivances in the shape of wheels, operated by men equally efficacious and far less expensive. Watchmen were employed to guard the varambas or protective bunds and at the first sign of their giving way at any vulnerable place, the watchmen set up a loud cry which was the signal for cultivators to rush to the spot and prevent damage by closing the breach. There was a well-ordered irrigation system with sluices and channels for distribution.

Cooperative farming prevented irrational wastage of waters which is such a distressing phenomenon associated with Indian agriculture at the present moment.

"Local administrative bodies," to quote an eminent writer, "arranged for the reclamation of uncultivated wastes by giving them to enterprising cultivators on favourable terms beginning with a free cultivation, gradually rising through a series of years to the normal revenue roll of the district, according to the quality of the land."

The Tamil Kural, a marvel of condensed wisdom has got some entrancing lines on agriculture, which are as true as they are beautiful. The contempt for the mere rent-receiver cannot be better expressed than in the wonderful line '[illegible],' meaning that he alone really enjoys his food, who has himself raised the grain, which forms his staple food. There can be no better vindication of the dignity of labour and the justice of taking all surplus lands from broad-acred land holders. The Kural lays great emphasis on the necessity of manure and personal attention to cultivation. It points out that lands on which crops are raised requires the daily attention and care of the cultivator and where that is not forthcoming, the lands frown with displeasure, like a virtuous wife who is neglected by her husband. The Tamil word for manure is "valam," meaning wealth. There can be no better recognition of the value and worth of manure in crop cultivation. The value of organic matter in the soil as a means of increasing the crop yields was well-known, and weeds, straw and stubble in plenty were ploughed under to keep up the fertility of the soil.

Agriculture was recognised by the early Tamils as the basis of all prosperity and was almost invariably accorded a national status in all the villages. There were no differences in the staple food grains grown in the various villages, tending to divergences in village cultivation and agricultural life. Consequently agricultural life, throughout Tamilnad followed the same pattern, the means employed and the implements used being the same from one end of the country to another.

One of the justly celebrated works of irrigation of the Tamils was the Anicut across the Cauvery river of which an old time English administrator wrote thus: "The Anicut is a judicious building whether the work of the Solar Rajah or anybody else" By Solar Rajah he, of course, meant the Chola Raja.

It is interesting to find from the Tamil classics of the Samghom period that sugarcane cultivation was quite common, on lands by the side of the rivers. India, according to K S. Latourette, author of "The Chinese, Their History and Culture" taught China the art of making sugar from cane. In describing the things which Kovalan and Kannaki saw on their way to Madura, the author of the Silappadikaram, the lay of the bracelet, observes as follows:- "They also saw rustic parts interspersed by villages where the rising fumes of the ovens, in which the sugar cane juice was being boiled, spread far and wide over heaps of stored corn, which appeared like dark clouds resting on mountains." The impact of numbers upon cultivated land had not begun to be felt and the age of controls was not even dreamt of. Haystacks to provide provender for cattle in scanty rainy seasons were also a welcome feature of every agricultural village.

Some of the names used by the ancient Tamils to denote various kinds of lands, still linger in place-names all over Kerala. 'Kurichi' was the word for the thick—wooded forests. The word is reproduced in Vadana Kurissi, Tenkurissi etc, well-known place-names in Malabar. 'Mulla' was the term for hilly tracts, covered over with bushes and shrubs and trees of moderate height. This word finds a place in place-names such as Mullakkara, Mullasseri etc. Pala or 'Palai' signified a desert. This word can be detected in Palappuram, Palakkal etc. 'Marutam' signified the cultivated regions Probably. this is the word which appears in Maruttem Kode, Maruthur etc, other place-names frequently met within Kerala. Last came the 'Neydal' or the sandy regions Very low lands were called pallam and the people who cultivated them Pallar. It will thus be seen that from the mist-crowned hills and mountains, with abundant verdure to the sandy regions where nothing grows but the cocoanut, each region had its own distinctive name and distinctive type of cultivation. Agriculture at the present moment both in the Tamil speaking areas and Kerala follows the same type of pattern and uses the same kind of implements; but it is a matter for serious consideration whether there has not been a general fall in the standard of excellence due to a change of outlook, the result of an exotic system of education and a resultant urbanisation of villages.

Atomic Reign

"..............................Champions fierce,
Strive here for mastery; and to battle bring
Their embryon atoms. To whom these most adhere,
He rules a moment; Chaos umpire sits,
And by decision more embroils the fray
By which he reigns; next him high arbiter;
Chance governs all ...."

Paradise Lost, Book II,

Trace Elements in Relation to Plant Life

BY

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Certain chemical elements essential for the maintenance of normal growth in plants and required only in extremely small quantities are variously known as Trace elements, Micro-nutrients or Minor elements. During the past twenty-five years a good amount of information has been added to our knowledge of the role of these trace elements in plant nutrition both as a result of laboratory and field work. Though the subject actually belongs to the domain of the plant physiologist, there are a number of conditions resulting in disease caused by deficiency of these trace elements often assuming serious economic consequences, so that it concerns equally the plant pathologist, the agriculturist and the horticulturist. At present, indeed, we know much more cf the plant pathological aspects of the trace elements than their physiological functions.

Early studies of nutritional requirements of plants consisted in the use of water cultures containing dilute aqueous solutions of various salts and the conclusion from these was, that, so long as the culture solutions contained salts involving the elements like nitrogen, sulphur, phosphorus, potassium, calcium, magnesium, iron, chlorine and sodium, a perfectly healthy plant would result. The presence of certain other elements in the plants were considered to be incidental due to their presence in the soil in which plants grow. In 1897 manganese came to be recognised as an essential element due to Bertrand's finding that it was constantly associated in the plant with the oxidising enzyme laccase. Maze, in 1914, drew attention to the necessity of zinc for the growth of maize and later claimed that aluminium and boron are also essential for the healthy growth of plants. A notable advance in our knowledge came when "reclamation disease" which is a pathological condition of the cereals was traced to the deficiency of copper. In 1939, the finding that one part of molybdic acid in 100,000,000 parts of culture solution could prevent mottling of of tomatoes established the need for MOLYBDENUM in plant gotwth. The essentiality of gallium and silicon has also been stressed.

Whether the indispensability of these trace elements is a general feature for all plants, we are not in a position to say with certainty, but the fact that plants differing as widely both anatomically and taxonomically as well as physiologically as the angiosperms and the fungi both exhibit these requirements lead us to believe that we are indeed dealing with a fundamental common factor with respect to plant nutrition in the case of both higher and lower plants. We cannot also say precisely whether we know all the trace elements required in plant growth but it is definite that manganese boron, zinc and copper are likely to be essential for nutrition of plants in general. The importance of the micro-nutrients had been overlooked for quite long time since water cultures contained "per se" sufficient quantities of these from the seeds used, from the impurities present in the salts forming the culture solutions, and from the traces solubilizing from the vessels preserving the culture solutions. A careful purification of the water and the various mitrient salts used, and the right choice of the culture vessels, are thus needed to obtain a thorough knowledge of the existence of the various trace elements. Another serious impediment for the advance in knowledge of the nutritive requirements of the trace elements was the lack of adequate quantitative methods of analysis, the quantities of trace elements involved being very minute. Recently, however the development of polarographic, absorptiometric and spectroscopic methods for the determination of micro-nutrients has materially aided the plant physiologist in his studies and definite advances have been achieved.

Numerous plant species are known to be dependant for growth on one or other of the micro-nutrients or at least have shown marked benefit by treatment with them. Certain well-recognised pathological conditions usually met with in the field are associated with deficiency of a particular micro-nutrient and some of these are of sufficient economic importance. Thus it is obvious that a ready means of diagnosing deficiencies of the various mineral constitutents of plants is likely to have profound economic value particularly when crop plants are concerned. Definite and readily recognizable symptoms characteristic for each element get manifested when it is available only in quantities below the minimum need and quite a number of such conditions are known. In the case of plants with short life periods, such as the cereals and leguminous plants, by the time unmistakable symptoms of deficiency have appeared it may be too late to effect a cure to the condition by the application of the deficient element, while in the perennials like the fruit trees etc. the longer life of the plants may provide adequate time for recovery after diagnosis and treatment. There are different ways of ascertaining trace element deficiencies such as are provided by analysis of the plant materials by standard methods or the physiological method adopted by Roach. In the former, the necessary data will be available only after sometime. The latter method consists of injecting the trace element salt solution into the plant (may be a leaf tip injection, or a leaf stalk, branch tip, shoot, individual branch injections) and observing the reaction which will usually be a response in the direction of a cure of the deficiency. A change to a brighter green colour of the leaves or the growth of more leaves are usual signs. Chlorotic leaves of plums recovered their normal green colour in two weeks when the leaves were bent and kept immersed in a weak copper sulphate solution containing 0'3 P. P. M. of copper proving that chlorosis in this case was a result of copper deficiency. Again by using sodium sulphate, magnesium sulphate, potassium sulphate, the "yellows" of the tea plant was shown to be due to sulphur deficiency the chlorosis being unaffected when chlorides, and nitrates of these metals were used.

Trace element deficiency symptoms are often so definite that the resulting conditions manifesting in crop plants are designated by common descriptive names such as for example the "grey speck" disease of oats, the *heart rot* of sugar beet etc. That diseases due to deficiency of manganese, zinc, boron and copper are so wide spread is readily seen from the following brief account.

Diseases attributed to a deficiency of manganese.

Development of small chlorotic patches in the intervenal areas of the leaves followed by the reduction or even cessation of growth, and the development of necrotic areas which may not be limited to the affected regions of the leaves but which may even affect the seeds as in the garden pea, are among the most general effects of manganese deficiency. The affected parts invariably show lower manganese content than the healthy parts and the pathological conditions can in most cases be rectified by the application of soluble manganese salts such as the sulphate, either as soil dressings or by spraying the foliage. That the symptoms are definitely the effects of the manganese deficiency have been proved by careful water culture and sand culture experiments, under controlled conditions using specially regulated amounts of manganese. By these methods, the "*grey speck*" disease of oats, "pahala blight" of sugar cane, "Speckled yellows" of sugar beet, spinach, mangold, red beet etc. the "marsh spot" disease of the peas and the "Frenching" of Tung trees have all been ascertained as conditions caused by manganese deficiency. Other aspects such as the possibility of microbiological disintegration of roots acting as predisposing conditions (or, as for instance, in the grey speck disease of oats, wheat, barley, rye and maize) have also been suggested. Alkaline or neutral salts have been found to induce manganese deficient conditions. Addition of sulphur, superphosphates etc. which decrease the hydrogen ion concentration of the soil, rendering the manganese in the soil more readily available for absorption, has shown to tend to diminish the incidence of "pahala blight" for example.

Diseases attributed to a deficiency of zinc.

Zinc deficiency affects fruit trees such as the citrus, apples, pecans, vines and stone fruits as well as maize and some other herbaceous plants. Intervenal chlorosis is the first symptom but in trees this is generally followed by symptoms of abnormal growth known as rosetting and variously called as rosette, little leaf, Mottle leaf or yellows according to the affected species. Among other facts, Reed (1935) has proved that in citrus, apricot, peach, tomato, maize, squash, mustard and buckwheat the general effect of zinc deficiency on the growth of the leaves appears to be retarded differentiation, the palisade cells appearing rhomboidal in shape rather than columnar, while the mesophyll is markedly compact owing to reduction in intercellular spaces. Hypertrophy of the cells sometimes occurs. Zinc deficiency promotes enlargement of the palisade cells rather than their multiplication or differntiation. Reed, also found that in the garden pea, wax-bean and milo at least 0.10 P. P. M. of zinc was needed for seed production, the numbers of seeds formed increasing with the increasing concentrations of zinc supplied. Pecan rosette, affecting pecan and walnut; little-leaf affecting apple, plum, cherry, peach, apricot, almond, grape etc., mottle leaf or Frenching of citrus and orange; the *Browning* of Tung trees; the condition known as *white bud* or *white tip* in maize; are all results of clearly defined conditions of zinc shortage. Solid injections of Zinc sulphate into the trunks of the trees appeared a most effective treatment. *Browning* of Tung trees has been cured by one fourth to half a pound of zinc sulphate per tree applied to the soil or a foliage spray with six pounds of hydrated lime and three pounds of 89% zinc sulphate in fifty gallons of water containing some calcium *caseinate spreader.* In the case of the white bud of maize, dressing of twenty pounds of zinc sulphate per acre induced a very much higher grain-yield than any inorganic dressing excluding zinc.

Diseases attributed to a deficiency of Boron.

Growing plants are generally so seriously affected that they die. The pith and epidermis of stems are damaged giving rise to characteristic hollow and roughened stalks. Thickening of the leaves, tendency for those to curve often with marginal scorching, mottling and pigment formation, also occur besides being cracked and wrinkled. Flowers may not form and even if formed, fruits may not set and even if set, become dwarfed and mal-formed and often develop internal necrosis. A good deal of investigations have been carried out on the *histology* of boron deficient plants including broad bean, tomato citrus, tobacco, sugar beet, maize, potato, apple, carrot, brassica species, radish, squash, sun flower, garden beet and cabbage. Hypertrophy of the cells of the cambium followed by its disintegration and that of the phloem (in the case of the case of citrus, tobacco, tomato, etc.) cessation of the cell division (in a number of species of brassica, cabbage, radish, etc.) in the root peax and degeneration of the root cap, various degenerative changes to the xylem parenchyma cells of the hypertropoy and collapse of the meristomatic cells (in squash) and of the more mature of the cortical cells of the apical region of the stem are all symptomatic of boron deficiency. Internal symptoms also manifest and vary from species to species. *Heart rot* of sugar beet and mangold, also called *Crown rot* or *dry rot* is most severe on alkaline soils and in dry years causing sometimes a complete destruction of the roots. The percentage of sugar in even the healthy parts of affected beets is less than that of the healthy roots so that from an economic point of view this disease may be of very serious consequences. *Canker and internal black spot* of red beet or garden beet, *Brown heart* or *Raan* of swedes and turnips are cases of extreme root rot affections. *Hollow stem* or *browning* of cauli flowers, *cracked* stem of *celery*, yellow tip or lucerne yellows, *top sickness* of tobacco, *Internal cork* of apples, *brown spotting* of apricots are all pathological conditons intimately associated with boron deficiency. Sodium tetra borate, Boric acid, hydrated borax, etc. are the various forms of boron used as sprays or soil dressings to correct these conditions.

Diseases attributed to a deficiency of copper.

Two very well recognised conditions caused by copper shortage are (1) an affection of the fruit trees known as *Exanthema* or *die back* or *chlorosis* and (2) a disease (known as *Reclamation disease*) of various herbaceous plants such as oats and other cereals, leguminous crop plants etc. occuring in the reclaimed health and moorland soils in various parts of Europe. *Exanthema* affects citrus species, rosaceous trees, olive, French prune, Japanese plums, apple pear, etc. The trees assume curved growths, gum containing blister-like swellings develop on the young shoots which often lose their leaves and die back. The fruits are small, brown spotted, and often the skin dries off splitting the fruit open. The copper content of leaves from healthy trees varied from 5·5 to 12.0 p. p. m. of the dry weight where as the leaves from affected shoots contained only 1 to 3·6 p. p. m. of the dry weight. The beneficial effects of copper sulphate in this condition has been now established. *Reclamation disease* was thought to be due to the toxic action of a peat constituent but has now been definetely recognised to a copper shortage symptom. copper sulphate prevents the chlorosis of the leaves and failure of seed setting in the cereals.

Diseases attributed to a deficiency of molybdenum.

Diseases attributed to a deficiency of molybdenum are only usually met within pasture plants and peas on certain iron stone soils in South Australia and Tasmania. But characteristic mottling followed by necrosis at the leaf margins in tomatoes, and abscission of flowers making fruit formation impossible have been ascribed to a deficient molybdenum condition. In the case of oats, Piper (1940) states that the inflorescence develops normally but the grains consist entirely of empty husks. Field plants are not known to be affected by molybdenum shortage. Deficiencies have been controlled by the application of ammonium or sodium molybdates, roasted molybdenate or wood ashes. Less than one lb. of sodium molybdate per acre may be sufficient for preventing deficiency.

The Functions of Trace Elements in Plants.

Very interesting suggestions segarding the essentiality of a trace element for plant growth and its position in the periodic table have been given by Tatcher (1934). Basing on his conception that "green plants are the energy absarbing and energy storing agents of the cycle of life" he concluded that manganese, copper and zinc, are to be placed with iron itself taking part in the regulation of vital oxidation reactions. If nickel and cobalt are included the group will contain six elements with consecutive atomic numbers 25 to 30. In this connection it is interesting to note that gallium recently shown to be essential for plant growth has atomic number 31. He regards that manganese and iron on the one hand and copper and zinc on the other, were pairs of mutually co-ordinating catalysts for oxidation reduction reactions, the former pair for reactions involving oxygen and the latter for reactions involving hydrogen transfers. Other interesting suggestions are those of Frey-Wyssling (193:) and Steinberg (1938).

The plant requires only minute quantities of these trace elements and this suggests that the latter are linked up with some catalytic processes. Boron however is thought to be nutritive in function rather than catalytic. Each element plays similar but not identical roles, for they cannot replace one another in the organisms. That manganese, zinc and copper are tied up with the formation of chlorophyll is a conclusion from the fact that the deficiencies of these elements characteristically induce chlorosis. Experiments on the utilization of trace elements in the presence of and absence of carbondioxide suggest that they have a role in the utilization of carbondi-oxide by the green plants. Although our knowledge about the functions of trace elements in plants is still obscure, the roles played by manganese, zinc and boron have been the subject of extensive studies. Manganese has been shown to be related to oxidations in the plant and is essential for the action of the oxidicing enzyme laccase. It is known that manganese and not iron directly catalyses nitrate assimilation from experiments with wheat root. For healthy plant growth it has been established by Shive (1941) there should be in the tissues an optium ratio of the active functional iron (in the ferrous state) to active manganese and Shive has found that this ratio should be within the range 1.5 to 2.5. Ratios outside this range result in characteristic pathological symptoms due to high iron and low manganese conditions. Manganese actually maintains an optimum ferrous iron concentration. Adjustment of iron and manganese concentrations by appropriate additions, restore normal conditions These findings also explain why manganese deficiency symptoms appear even in the presence of high total manganese while in other regions thereverse has been observed, low manganese contents manifesting no deficiency symptoms. These findings were derived from experiments with soya bean and maize seedlings. Swanbuck (1939) studied cat-ion absorption by tobacco and found that calcium antagonises the absorption and utilization of manganese, while potassium is indifferent. He found that the translocation quotient which is the ratio of the manganese content of the shoot to that of the Root—giving a measure of the mobility or relative translocation of the manganese—shew clearly the effect of calcium in reducing the intake of manganese and its translocation to the leaves while no such effects were observed with pottassium Zinc is concerned with the functioning of *sulfhydryl* compounds such as the cysteine in their r gulation of oxidation reduction potential within the cells. Chandler (1937) noted that zinc deficiency brings about inhibition of certain processes of carbohydrate transformation. Skoeg (1940) noted a connection between zinc and the growth promoting substance auxin in the case of tomatoes and sunflower and concluded that zinc functions in the maintenance of normal auxin contents of plants. This result explains why zinc deficiency may lead to retardation or cessation of growth. Zinc also functions as a catalyst in the oxidation processes in the cells

Copper is now recognised to be a constitutent of oxidising enzymes like the catechol oxidase or polyphenol oxidase (as in potato tuber). The enzyme appears to be a copper-protein-complex containing not less than 0·3% of copper. These enzymes are very widely distributed in the plant kingdom. The role of copper in vital oxidations forming with zinc a pair of mutually co-ordinating catalysts is well known. It may be noted here that recent researches by Keilin and Mann, and others have enabled to isolate from plant tissues compounds containing trace elements like copper and zinc and possessing enzyme properties, the catechol oxidase, for example.

Boron exerts influences on the water relations of the protoplasam on the absorption of ions (favourable for cat-ions and retarding for anions) on the formation of *pectic* substances in the cell walls (an essential part in the carbohydrate fat and nitrogen metabolism in the plants). Accumulation of sugars in the leaves of tomatoes and a corresponding reduction in the stem are often the results of impeded boron function. Development of high acidity in the cells of *the pith and cortex* (3 8·4·4) in cotton seedlings resulting in the break-down of the cells, failure of nitrate absorption, accumulation of ammonium nitrogen in the cells, decreased rate of sugar oxidation and *amination* of carbohydrate derivatives (so that protein substances necessary for the maintenance of protoplasm are not formed)—are all among other effects dependent on unsatisfactory boron function.

From the above survey it may be seen that few scientific discoveries have had greater economic and social effects than the recognition of the importance of the trace elements in plant nutrition The problem embraces the domain of both the plant physiologist and the plant pathologist—the work of the former will evolve optimum conditions for plant growth while the latter will strive to diagnose and eradicate pathological conditions resulting from excessive or deficient conditions of adequate plant nutrients. Early diagnosis is an imperative factor in the control of plant diseases. Since crop plants satisfy a considerable part of the mineral requirements of cattle, the relationship between the mineral deficiencies of plants and the health of stock feeding on them has to be carefully elucidated. Investigations of the relationship of the soils and climatic actors to the incidence of plant disease are also necessary. Manganese availability for example is a factor of acidity of the soil, availability decreasing with decreasing acidity. Consequently liming adversely affects manganese absorption particularly in humus-rich soils. These and allied aspects are not yet completely understood. Severity of plant diseases vary in different seasons due to climatic changes. Boron deficiency is more common in draughty weather than in wetter seasons, probably the different moisture contents of the soils having varying influences in trace element availability. The molybdenum content of the herbage of scouring pasture assumes proportions toxic to animal when the pH. of the soil is high The role of soil micro-organisms on the oxidation and reduction of compounds of trace elements is another important factor determining satisfactory plant growth. Low availability of zinc is thought to be the result of certain microbial activities, often induced by high concentrations of phosphorus.

Much work is now being carried out both in the laboratory and in the field so as to achieve a very rapid expansion in our knowledge of the physiology and pathology of the plant in relation to trace elements, aiding to a great extent the amelioration of plant disease conditions and securing better economy in plant life.

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FACTS AND FIGURES

Text of a talk by Mr. V. Seshasayee to the senior members of the operating personnel on 9—5—1948.

IT is unnecessary for me to tell you that this factory is the first plant of its size in the whole of India and in the East. The undertaking is also in the nature of a pioneer venture, as much that has been done and that has to be done, had to be thought of and planned especially to meet our circumstances and there was no exactly similar plant to copy from. From your experience here during the past over 3 years, probably you have already learnt that we have to a very great extent to depend on our own resources and wit. In one way, this is good as it gives us the complete range of experience needed for running a plant of this complexity and magnitude. We must all realise that we can never give too much attention to the plant or the process. It will take and require all that we are capable of and the vigilance of all people, night and day. We have therefore to work to our full capacity and I have no doubt that you will rise equal to the occasion as you have so far done.

If the following picture is visualised, you will appreciate the importance of the services we are engaged in. Taking Travancore alone, we have a population of over six millions (1.3' lakhs recurring) families and the annual food requirement is of the order of 6'45 lakhs of tons. At an average, two families will consume one ton of rice per year. A family has 4'5 souls on an average. From the Government statistics it is seen that there are more than 6'3 lakhs of acres under paddy cultivation so that if each acre is made to yield a minimum of one ton of rice per year, the problem would have been solved and we would have achieved something really substantial and concrete. The deficit in the State is, however, of the order of about 4½ lakhs of tons. With the judicious application of even 30,000 tons of ammonium sulphate, 40,000 tons of superphosphate and 20,000 tons of calcium carbonate, this deficit can be covered and optimum production achieved. We must all set this as our target to be reached within the next three years.

The wealth of the State based on the present price of Rs. 300/- per ton of rice prevailing in the State would have increased by Rs. 13½ crores; per capita increase will be Rs. 22/8/- per annum.

The above represents but two-thirds of the possible output of our factory. The remaining one-third can similarly augment the wealth and production in surrounding areas or in the increase in cash crops in Travancore itself by another Rs. 7/- crores.

The selling price of the fertilisers manufactured in our factory, based on current prices, is only:

Rs. 320 x 50,000	Rs 160,00,000	$AmSO_4$
Rs. 230 x 60,000	Rs. 138,00,000	P_2O_5
Rs. 20 x 15,000	Rs. 3,00,000	Calcium Carbonate.
Total	Rs 301,00,000	

Approx. Rs. three crores.

The above is only elementary arithmetic and probably many of you have already pondered over these opportunities and possibilities and appreciated how striking it is that some 1000 persons engaged in a scientific venture are manufacturing with local raw materials, like air, water, wood and gypsum and some imported material, products worth Rs. 3 crores which are capable of increasing the food production of Travancore by Rs 13½ crores and of the surrounding areas by another Rs. 7 crores.

What greater reward do we need than the knowledge that we are all engaged in such a vital and useful service and that we shall go all out to carry this undertaking and instrument for service from strength to strength and ever increasing strength.

These are not idealistic pictures impossible of achievement in the normal course but based on achievements made and sustained in other countries under even worse conditions than are prevailing around us. Our will to achieve this and discipline and persistent efforts is all that is needed to realise the target.

I am sure you will not fail in this nor do I think you will be expecting individually any special recognition or reward though recognition and reward will come and it must come.

It is fortunate that at the head of the Government of His Highness the Maharaja, we have got three Ministers who are fully representative of the entire people and who appreciate the importance of this industry. It is up to us to prove that we deserve the trust and confidence His Highness and his Government have in us.

In addition to the above benefits which this industry is capable of directly giving and achieving, it is also a basic chemical industry capable of supporting and giving room for numerous other industries. I am sure you will all share with me, therefore, the feeling that it is a privilege that we have been allowed to play our part in such a vital undertaking. While we have got all the potentialities, we are yet to prove and bring out their usefulness. We have still some hurdles to overcome. Transport has to be completely organised as the bulk of cost of our raw materials is taken up by transport charges over 60% in the case of wood, 40% in the case of gypsum etc. Also, we have to become very efficient if we want to hold our own in the international competition. We shall achieve all these if we develope a spirit of unstinted loyalty and devotion to the undertaking and of the needed sacrifice.

Capitalism, Socialism, all have their value and their draw-backs. We can evolve a system that will be worked for the benefit and service of all while maintaining the necessary recognition and scope for private enterprise and initiative.

"THIS FRUITFUL CRYSTAL"

Question Box

(In this section answers are given by our Agricultural Chemist to questions received from the public on soil, agriculture and use of Fertilisers)

Question No. 13.

What is the control measure against the attack of rice bug on paddy crop?

Answer:

This insect, which goes by the entomological name of "Leptocorisa acuta", is present in nearly all the rice growing regions. Normally, it is not a serious pest; but at times when the climatic and other conditions are found favourable, it multiplies at an alarming speed and causes great havoc. This bug is an elongated greenish creature, which may sometimes be seen in hundreds and thousands on the fresh ear heads of paddy. When these ears are in the "milky stage" these bugs suck in the milk out of the grains and as a consequence the grains do not develop at all or they may be found partially filled. The grains are also discoloured as a result of this predatory attack. If unchecked the resulting loss may be considerable. Hand-netting may be adopted to capture and destroy these pests. A convenient form of hand-net can be made by attaching a conical piece of thin muslin cloth or a mosquito curtain to a circular frame or cane, which is also provided with a handle. With this net a boy can easily catch these insects. Removing of grass from the field-bunds, where the insect generally breeds will also be helpful. Spraying the ears with a deterrent insecticide, such as, gammexene will also be greatly helpful in checking these insects.

Question No. 14.

How does iron benefit plant growth?

Answer:

Iron is one of the important minor plant nutrients. It is considered to be closely connected with the assimilation of magnesium and thus responsible for the production of chlorophyll, the vital green pigment of all plants. Lack of iron produces severe chlorosis, the sickly yellow colouration of plants. Generally all soils contain adequate amount of compounds and hence it is only a question of non-availability to plant-roots, which is common in alkaline soils. Iron deficiency is therefore chiefly caused by peculiar soil conditions Unless the extra alkalinity is corrected it will be impossible for the crops to take in an adequate amount of iron and there will be no use in adding a few pounds of soluble iron salts. The correction of alkalinity by application of gypsum, will automatically make iron available to plants. In severe and emergent cases, however, a very dilute solution of ferrous sulphate can be sprayed over the plants or trees. In countries, where soil science is far advanced, solid iron salts are even injected into stems of fruit trees, suffering from lack of available iron.

Question No. 15.

What is meant by rotation of crops and how is that system beneficial to the soil?

Answer:

Rotation of crops refers to cultivation of different kinds of crops one after another, instead of continuously raising the same crop year after year in the same soil, which is termed mono-culture. In the early beginnings of agriculture' only mono-culture was adopted, but later on man found that the soil gets tired speedily if put under the same crop continuously. If different crops are raised the soil seems to stand it better. There are many advantages in rotating the crops:-

1. Though all crops need the same kinds of plant nutrients all of them do not take it in the same quantities or proportion; some crops favour some plant nutrients and take them more than the others, Thus if a particular crop is grown year after year the soil gets deficient in that plant food favoured by that crop, which gets exhausted and becomes the limiting factor for growth. If different crops were to be raised, there would certainly be a more balanced feeding.

2. Again, crop-diseases and insect pests will multiply at an alarming rate if the same crop is to be grown continuously. Rotation will check their multiplication.

3. A leguminous crop, if introduced within a particular rotation, will increase the soil-nitrogen and thus enhance the fertility-potential.

4. As the crops within the system of rotation will have among them both shallow rooted (cereals) and deep rooted ones (crops like cotton, tobacco, etc.) they will feed both from the upper and the lower layers of the soil; thus the soil will be better exploited.

5. Rotation means, varied farming, including cash crops, food and fodder crops and soil renovating crops and so it will, in the long run, benefit both the farmer and the soil in more than one way.

Question No. 16.

Why is it said that liming should not be done immediately before the planting of potato?

Answer:

It has been experimentally proved that the potato crop prefers a bit of acidity in the soil. If the soil is neutral or alkaline the crop becomes susceptible to a disease called the 'scab'. Liming just before raising a potato crop, will bring down the acidity and thus make the crop susceptible to this deadly disease. If a particular soil is extremely acid (p H far below 5) then it should be limed of course but the liming can better be done after harvesting the potato crop, and only the exact amount of lime that is necessary to bring down the excess of acidity should be added Over-liming, up to the neutral limit should on no account be done. If liming is done after the harvest, there will be a few months time for the soil-pH to get adjusted. The lime must be well worked into the soil. For potato crop fine chalk will be preferable to lime to bring down any extreme acidity, as there will no drastic and too toxic action in the case of chalk.

NEWS & NOTES .... in brief

Study of Soil Fertility.

Necessity for Increasing The Yield per Acre.

Some practical recommendations and resolutions in regard to the various measures necessary to step up food production in India were adopted at the session of the Crops and Soils Wing of the Board of Agriculture held in April 1918 at Rajaji Hall, Madras. Sir Datar Singh, Vice-Chairman of the Council of Agricultural Research presided.

The production of more food in the country, it was felt, could be effected *only by increasing the yield per acre* since not much new land was available for cultivation.

In the interest of economy and scientific efficiency it was recommended that the experimental stations in each region should be the centre of all experimental work on soils and crops pertaining to the region. It was further advisable that such stations should be used both by the Central and Provincial Agricultural Research Institutions in co-operation.

Another recommendation was the necessity for a rapid reconnaissance soil survey in Provinces and States without any delay in order to demarcate more clearly the different soil and climatic regions.

The resolution on "Soil Fertility" stressed the importance of classification of land into areas suitable for crops, trees or for pastures and to carry out suitable crop rotations in which legumes that build up soil fertility should be evolved to fit the different soil climatic regions and cropping systems. More systematic investigations should also be carried out with different forms of organic manures especially green manures, farmyard manure and compost, alone *and in conjunction with artificial fertilisers.*

A further recommendation sought to making of composts obligatory in Cities, Munciplities and organised Panchayats Continued assistance from the Central Government was thought necessary for conversion of town compost into manure. It was also essential to have an official organisation for the distribution of improved varieties of seeds. Dealing with publicity and propaganda on agricultural research a resolution suggested that model, agricultural villages should be arranged in places where people congregate for fairs and festivals.

Compulsion for New Methods of Agriculture.

Only way for a healthy prosperous peasantry.

Broadcasting a talk from Madras AIR centre, on 1st May, the Madras Revenue Minister reviewed the agrarian problems in the Madras Province. He disclosed that the

Govt. are already planning a few experimental cooperative farms this season. He felt that the targets of maximum food production cannot be achieved by simply extending the area of cultivation but by getting maximum out of the existing cultivated land. To achieve this objective, one of the first things to be done is soil conservation by the construction of contour bunds around steep areas, thus helping the rain water to soak into the soil, and lead the surplus water into safe channels. Dr. Everest had estimated that the Ganges alone annually carries off enough soil which could duly be removed by 1000 ships having 100,000 tons capacity working daily throughout the year. Based on this estimate, the loss of fertile soil through soil erosion by all the rivers, streams and rivulets in this country is really tremendous. He added that experiments are being conducted under Government auspices to prevent this loss.

The other important considerations for the increase in crop-yield are:—

1) The use of selected good seeds of new strains.
2) The application of organic and artificial manures to soil-depleted lands and
3) The encouragement of the growth of leguminous crops.

In conclusion, he remarked that even in the highly literate countries it took more than two decades to persuade the farmers to adopt improved methods of agriculture and in this country it will take a longer time. To achieve peaceful rural revolution, within a fraction of the life-time of the present generation, recourse was to be had to some kind of compulsion in introducing new methods.

Growing Faith In Chemical Manures.

Some interesting suggestions in regard to the short-term programme for development of the food resources of our country was given by Sir V. T. Krishnamachari, Dewan of Jaipur while delivering the presidential address of the Bombay Provincial Co-operative Conference. The necessity for setting up a machinery to organise a nation-wide campaign for compost-making and for the distribution of compost and chemical manures to all irrigated land or lands in areas of good rainfall was stressed by him. He recalled the suggestion in the food plan of the Royal Institute of International Affairs, in this regard, which provides for one maund of ammonium sulphate for every acre of irrigated land or lands receiving good rainfall. He advocated the setting up of a "work party" for each compact group of 20 to 30 villages with higher supervising and other agencies to implement the scheme. The necessary supplies of chemical manures should be obtained by the Central Government for all Provinces and States and these latter should distribute them to agriculturists at concession prices.

The necessity of distributing good seeds to agriculturists—wheat rice etc.—on the widest scale possible was the next point of importance. An extensive programme of well-sinking should also be carried out to provide the necessary irrigation facilities in areas where they can be dug without much difficulty.

Paddy Researches in India.

Important results showing earliness and increased grain yield in the Indian varieties of rice have been reviewed in a recent book on Crop Production and Environment by Dr. R. O. Whyte.

Success of Russian scientists for inducing earliness in crop varieties is based on pre-sowing low temperature treatment of seeds which is widely known as Vernalization. In paddy such a method of low temperature treatment of seeds was of little use in this country. On the contrary adverse effects were noticed. A different method based on the influence of day-length on flowering of local varieties has been investigated by Dr. Sircar with good success. The seedlings are exposed to short days of 8 or 10 hrs. for 4 to 6 weeks, then transplanted, after which no further treatment was required. By adopting this procedure one local *aman* variety was found to flower within 47 days while the untreated took about 135 days. In another variety an earliness of about 2 weeks associated with 10% increase in grain yield has also been noticed. The results so far obtained indicate great possibilities of increasing rice production by improved methods of cultivation. Researches carried indicate that by suitable treatment five varieties of Indian rice could be induced to flower as early as the Russian scientists have claimed.

Salem Bauxite Ores to be Exploited.

Mr. H Sitarama Reddy, Minister for Industries and Labour (Madras) declaring open the Canancre Spg. & Wvg. Mills at Kakkad on 17th March '48 referred to the industrial potentialities of the Madras province and stated that the industrial capacity of any place could be judged from the quantity of iron and steel, caustic soda and sulphuric acid it produced. Sufficient facilities were not provided for the production of these basic materials in the province.

In Salem, iron bauxite and magnesite ores occur in juxta position and they have been awaiting exploitation for a long time past. Officers from Madras had recently discussed the starting of steel manufacture in Salem with the Government of India and efforts were being made to establish an "Industry" for the utilisation of bauxite by the erection of a suitable plant in Salem. Proposals for the manufacture of other basic Chemicals like Soda Ash and fertilisers like Superphosphate have also been sponsored by the Government.

Ruhr of India.

The U. P. Government have recently sanctioned a grant for one of the largest dams in Asia across the rapids of the river Rihand in Mirzapur District. The project which is expected to cost 16 crores of rupees has a catchment area of about 5000 square miles and about 430,000 million cubic feet of water can be stored in the reservoir. A hydro-electric generating station with an installed capacity of 230,000 K. W. provides firm power production of 132,000 K. W. The scheme is unrivalled in its cheapness and simplicity and the site lies in a territory so rich in mineral resources that it has been aptly termed by an eminent engineer as the 'Ruhr of India'.

Round about the dam site there are deposits of coal, quartz, felspar, mica, calcite, corundum. sillimanite, limestone (suitable for cement industry) white quartzite (suitable for glass industry) and bauxite (aluminium ore) which all make to contribute a very happy future for the potentialities of a multi-purpose scheme in this area.

Some of the important features can be considered to provide an idea about the vastness of the scheme. The quality of coal can be processed and utilised as "second grade coal". The electricity from the project can be used for winnowing the coal and for starting some of the by-products ndustries like *ammonium sulphate*, coal-gas etc. Bauxite ores can be successfully tapped to provide aluminium and deposits of calcite and marble can be used for the manufacture of calcium carbide. Corundum deposits can be directly used for the manufacture of abrasives. Limestone bands of the requisite degree of purity for the manufacture of cement, and other raw materials like shale and clay, occur in abundance. The prospects for a ceramic industry in this area are bright particularly when cheap power for crushing rand heating becomes available. Serious attention is being paid by the U.P. Government to provide modern transport facilities to develop the industries in these areas,

Hirakud Dam, The First Multi-Purpose Scheme.

The construction of the Hirakud Dam ,the first multi-purpose project undertaken by the Central Government at Sambalpur in Orissa marks the ushering of an era of all-round prosperity for Orissa. The project which is expected to cost Rs. 47 81 crores is the first stage of construction of a series of dams across the main river, Mahanadi and its major tributaries and of ancillary irrigation, power and navigation works.

The dam site is to be nine miles upstream of Sombalpur. It will be 150 ft. high and 3 miles long. Nearly one third of the Dam will be reserved for surplusing the flood water of this giant river. Six irrigation channels will be taken out from the dam to irrigate 11 lakhs of acres of land annually. Hydro electric power will be generated firstly at the Dam site and secondly at a place 2 miles down-stream where on an average a head of nearly 70 feet is available. Development of power will be to the extent 350,000 K. W. so that the industrial and agricultural development can be planned and proceeded at once. From the cheap power developed, aluminium, steel, paper, cement and textile industries can be set up in the neighbourhood of Sambalpur. The area submerged under the proposed reservoir will be 1,35,000 acres out of which 70,000 acres will be cultivated land. By regulating the release of water from the reservoir and by removing obstacles and providing conservation measures, ships six to eight hundred tons can ply from sea to Dalab and then to the Hirakud Pool.

It is felt that the project will result in indirect benefits, such as increase in food production, development of basic industries (thereby providing employment to millions), provision of almost complete flood control and provision of navigational facilities and clear domestic water supply in thousands of villages.

The ten Commandments of good Organisation.

If you are a manager (foreman or supervisor), no matter how great or small your responsibility, it is your job in the final analysis, says the American Management Association, to create and develop voluntary co-operation among the people you supervise. The American Management Association's comments are as follows:—

(1) **RESPONSIBILITY:** Definite and clean-cut responsibilities should be assigned to each executive, manager, supervisor and foremen.

(2) **AUTHORITY:** Responsibility should always be coupled with corresponding authority.

(3) **RESPONSIBILITIES: Changes in:** No change should be made in the scope or responsibilities of a position without definite understanding to that effect on the part of all persons concerned.

(4) **ORDERS:** No executive or employee, occupying a single position in the organization, should be subject to definite orders from more than one source.

(5) **ORDERS, GIVING OF:** Order should never be given to subordinates over the head of a responsible executive. Rather than do this, the officer in question should be supplanted.

(6) **CRITICISMS:** Criticisms of subordinates should be made privately. In no case should a subordinate be criticised in the presence of executives or employees of equal or lower rank.

(7) **DIFFERENCES OR DISPUTES:** No dispute or difference between executives or employees as to authority or responsibilities should be considered too trivial for prompt and careful adjudication.

(8) **DISCIPLINARY ACTIONS, PROMOTIONS AND WAGE CHANGES:** Promotions, wage changes and disciplinary action should always be approved by the executive immediately superior to the one directly responsible.

(9) **CRITICISM:** No executive or employee should be an assistant to and at the same time, a critic of the person he is assistant to.

(10) **INSPECTION FACILITIES:** Any executive whose work is subject to regular inspection should, whenever practicable, be given the assistance and facilities necessary to enable him to maintain an independent check of the quality of work.

FACTS THAT INTEREST

Helicopter—An Agricultural Tool.

Tens of thousands of acres of field crops and orchards in America have been dusted and sprayed by more than 30 customer operated commercially licensed helicopters during more than 2,100 hours of flight. Equipped with special hoppers, carrying 400 pounds of insecticide, dust tubes, "gates" and other special paraphernalia, thi helicopter is growing up as an important agricultural tool.

The helicopter looks like an answer to the problem of getting valuab'e crops dusted quickly and efficiently at the exact time. The growers it is said, are reporting a 100% kill within six hours of the application of the insecticide.

The helicopter has also been assigned to spraying hormone solutions to delay apples dropping before fully ripe and ready for picking. Still another use is in seeding work, which is presently contemplated in Argentina.

Indian Bamboo as substitute for Steel.

An overall annual deficit of one million tons of steel as against India's minimum requirements of two million tons has led to an intensive research for substitutes.

The Indian Bamboo, enormous quantities of which goes to waste every year is the latest claimant for an effective substitute for steel. It is stated that the bamboo can be used as a substitute for steel in concrete in the construction of roofs, posts, doors and window frames and floors of buildings and a life of 30 years is predicted for structures made of bamboo reinforced concrete.

Further research in this direction will, it is understood, be undertaken by the Forest Research Institute, Dehra Dun, and if the results are successful, the costs of country's housing programme will have been considerably reduced and its dependence for other building materials from abroad will have been curtailed.

World Of Tomorrow.

Plastic Skin For Packaging.

A plastic skin process for "preservation packaging" has been developed by a Birmingham firm.

The process, which is intended primarily for tools, consists of dipping an article into molten ethyl cellulose. When cool, a snug perfectly air tight skin is formed which, being transparent, enables the maker's name and identification markings to be seen clearly. This skin cannot be chipped or knocked off; it is removable only by slitting and stripping.

This new packaging process is claimed to have a number of other advantages over the established methods. The chief among them are its ease of application—one operation only is needed—complete protection against abrasion and corrosion in transit and also against damage in handling.

Further, the plastic nature of the coating allows for expansion or contraction of the metal when exposed to rapid temperature changes. On removal of the plastic skin, the tool is ready for use as it is lubricated with a film of oil automatically exuded from the coating material.

Atomic Age And The Shape of Things To Come.

It is said that the day is coming nearer when 170 tons of atomic materials a year will provide all the energy the world needs. Then we will have smokeless cities, depending upon atom-produced electric power. Ships will cruise almost indefinitely, coming to shore only to get supplies for the passengers, not oil or coal; atom driven locomotives will haul trains across the continets. One scientist predicts that atomic energy will introduce a 24 hour-work week. It may not be tomorrow or the day-after. But it is expected to come eventually.

Tamed Atomic Bomb.

One great step has come with the recent announcement that '*tamed*' *atomic bomb* has been working down at the Los Alamos Laboratories (U. S. A) since last November. The announcement was the most important in the field since the announcement of the atomic bomb in World War II. The tamed atom bomb is made of plutonium just as was the bomb dropped over Nagasaki. But instead of letting its energy go with one devasting explosion, this bomb is said to give off its energy slowly and under perfect control.

Medicine to benefit by Atomic Research.

Among the triumphs of recent atomic research is the production of artificial substances which are cheaper and many times more active than radium. One of these substances ("radio-active isotopes") is radioactive sodium. The activities of radioactive sodium and similar substances, however, are short-lived. This, happily, is a distinct advantage, for after radioactive sodium has done its work on diseased tissue, it becomes ordinary magnesium, and passes out of the body through the usual channels. Thus, the radiologist can be sure that no uncontrolled radioactive residues are left in the body.

With radioactive sodium, it is possible to trace the progress of food through the digestive tract, note the rate of movement, and in some cases to reveal the position of obstructions.

Atomic research has given us the electron microscope With this, it is possible to "see" invisible viruses which are responsible for many diseases of human beings, animals and plants. Smallpox is one example, the common cold another. These viruses cannot be seen even with the aid of the most powerful microscope employing lenses because they are smaller than the smallest wave-length of light. With the electron microscope, a beam of electrons is focused without lenses by an arrangement of electro-magnets and electrical fields. The electron microscope is able to reflect invisible viruses as a pattern and that pattern can be photographed. The great significance of the electron microscope is that it offers a new approach not only to the study of viruses but also to cellular changes which stand at the root of all living processes.

The knowledge, that one day may be open to us, through atomic research may point to a science of healing which will be basic in its simplicity, and thereby end the disconnected and complicated healing methods of to-day. In brief atomic research is the science that deals with the fundamentals of Nature, the way things are made, the way they work. In the single field of medicine it presents a key which may unlock secrets of our being which have baffled thinkers of every age since civilization began.

Size of An Atom.

It has been quite accurately determined that if all the H_2O molecules in a tumbler of water were by some magic, each turned into a grain of sand, they would bury the entire United States in a sand bank a hundred feet deep.

The atoms are smaller still. One atom of hydrogen measures 1/250,000,000 of an inch. Within this infinitesimal space an electron revolves round a proton at a speed of 1,400 miles per hour That "earth" revolves about its "sun" 7,000,000,000 times in 1/1,000,000,000 of second.

Statistics of Nitrogen Fertiliser Produced & Used.

(Showing the increasing popularity of the Nitrogen Fertiliser)

IN METRIC TONS OF NITROGEN.

COUNTRIES	1945—'46		1938—'39		1937—'38	
	Production	Consumption	Production	Consumption	Production	Consumption
Canada ...	179,000	21,000	49,500	10,000	51,500	9,500
U. S. A. ...	520,000	611,000	188,000	332,000	185,500	327,000
Chile ...	254,000	5,000	225,000	5,000	224,000	5,000
America other and West Indies ...	1,000	28,000	1,000	38,000	1,000	23,500
Australia ...	7,000	17,000	6,000	14,000	4,500	15,000
Japan ...	80,000	80,000	425,000	419,500	416,500	454,500
China ...	10,000	10,000	1,000	30,000	1,000	28,500
India/Ceylon ...	6,000	45,000	5,000	29,500	5,000	26,500
Other Asia ...	—	8,000	—	44,000	—	42,500
Egypt ...	—	65,000	—	77,500	—	76,500
Other Africa ...	—	11,000	—	18,500	—	19,500
United Kingdom ...	248,000	166,000	128,000	68,500	135,000	68,000
Norway ...	91,000	23,000	85,000	11,000	85,500	10,000
Belgium ...	87,000	90,000	84,000	53,500	82,500	54,500
Holland ...	25,000	80,000	105,000	95,000	104,500	86,500
France ...	70,000	220,000	150,000	184,000	148,500	175,000
Other Europe (excl. U. S. S. R.) ...	300,000	400,000	1,090,000	1,026,000	937,000	975,000
TOTAL (excl. U. S. S. R.)...	1,878,000	1,880,000	2,542,500	2,456,000	2,382,000	2,397,000

(Chemical Age, 25th Jan. 1947)

FACT NEWS

ANALYSIS OF FACT PRODUCTS.

(a) AMMONIUM SULPHATE:

It can be seen from the following that Ammonium Sulphate manufactured by F A C T is about the same quality as the imported Ammonium Sulphate. The analysis of the samples were conducted at the Government Agricultural Laboratories, Coimbatore.

Imported Ammonium Sulphate			FACT Ammonium Sulphate	
M/S. I. C. I. (India) Ltd., Madras.	M/S. D. S. Narayana & Co. Madras.		M/S Parry & Co, Ltd, Madras.	M/S. Scientific Fertilisers Co. Ltd, Coimbatore.
Lab. No. 1434.	I White: Lab No. 1275.	II Brownish: Lab. No. 1276.	Lab. No. 1332.	Lab No. 1273.
Moisture % 0. 06	0 12	0. 24	0.05	0 08
Nitrogen % 20. 82	20. 45	20. 25	20. 58	20. 57

(b) SUPERPHOSPHATE:

CONTENTS	PERCENTAGE
Moisture	11.02%
Free Acid	5.76%
Total P_2O_5	22.70%
Water soluble P_2O_5	19.90%

It is to be noted that FACT Superphosphate has an analytical value of nearly 20% water soluble P_2O_5, and therefore it is of a superior grade. Generally the Superphosphate available in the market has only about 16% of water soluble P_2O_5

Sports

In keeping with the allround developments of FACT, The FACT Sports Association has been making remarkable progress. The out-door games, especially foot-ball, volley ball and badminton received a new impetus. Inter-Division tournaments were held in foot-ball and volley ball. Given below are the results of the various matches.

FOOT BALL

The first match which was between the Gas Division and the Engineering (B), ended in a win for the Engineering (B) by 2 goals to 1. P. N. Menon as centre forward, and Gopalan as full back played well for the winners. The odd goal for the Gas Division was scored by M. G Menon by a dexterous use of his head.

In the second match between the Chemical Control and the Administrative offices, the former won by 2 Goals to 1. David, Cherian, and Burnard played well for the winners, while Chacko and Dr. Menon did well for the losers.

In the 3rd match the Sulphate Division beat Transportation by 13 goals to nil by a real baker's dozen.

In the 4th match Synthesis beat Engineering (A) by 7 goals to nil, inspite of the sturdy defence put up by George as full back. Mahadevan and John played well for the Synthesis.

The 5th match, the semi-finals, between the Sulphate Division and the Chemical Control, a hotly contested match in the tournament, ended in a win for the Chemical Control by 1 goal, scored by Vasudevar; Sulphate failing to convert a penalty. Bernard, Cherian, Panicker, David and Pillai combined well for the Chemical Control while Ranganathan defended the goal ably. For the Sulphate, Velayudha Menon as full-back, K C. George as forward, and De Baussett as goalie gave a fine display.

In the 6th match between the Engineering (B) and the Synthesis, the former won by 3 goals to nil. P. N. Menon played solo for the 2 goals he scored while by a similar attempt Madhu scored 1 goal. Gopal as full-back played exceedingly well for the Engineering (B).

The 7th match, the finals, played on 18-5-'48 between Engincering 'B' and the Chemical Control ended in a draw, each side scoring one goal. Madhu scored a goal within 15 minutes from the Kick-off and victory for Engineering 'B' seemed to be well in sight, when just a few seconds before the final whistle Bernard, of the Chemical Control scored a lovely goal and equalised the scores, thus necessitating a replay of the match.

INTER—DIVISION VOLLEY BALL TOURNAMENT

The Engineering and the Gas Division teams came up for the finals which was played on 17-5-'48. The Engineering proved too good, and won the match in straight games.

The members of the winning team.

1. C. P Gopinath
2. N. V. Sivaram
3. R. Anantha Raman
4. Verghese
5. Gopal
6. Subbarao.

Our congratulations to the members of the winning team.

BADMINTON TOURNAMENT

14 teams competed for the tournament and 11 matches have been played so far.

K. R. G. Nair and partner after beating K. B. Panicker and partner in the first round, Chacko and partner in the second and Mahadevan and partner in the third have come up for the finals. Mahadevan and partner, the left handers, indeed played a good game and went down fighting.

In the other half Madhavan Nair and partner beat Narasimham and partner (a brotherly combination) in the first round. The brothers put up a good fight but were evidently out of practice. In the second round Madhavan Nair and partner beat S. B. Iyer and partner moved up to the semifinals to be played against Balakrishna Pillai and partner.

CONTRACT BRIDGE TOURNAMENT

This event attracted 13 entries. The finals which was played on 6-5-48 between Anantaraman (Engineering) and Lakshminarayanan (Gas Division) on the one hand and N.N. Simha (utility) and K. Bashyam (protection) on the other resulted in a win for Anantaraman and Lakshminarayanan. Our congradulaticns to the winners.

Distinguished Visitors

The Hon'ble Sri K. Madhava Menon, Minister for Agriculture, Madras, accompanied by Mrs. Madhava Menon visited our factory on 6-5-1948. The Minister and part were received by Mr. Seshasayee. They were taken round the extensive factory premises stage by stage and the working of the various plants and machinery units—from the producer gas section to the Ammonium Sulphate works—was clearly explained to the visitors. The party then went up the river and had an impressive over-all view of the factory. The Superphosphate plant and the experimental farm were next inspected. The Hon'ble Minister and members of the party expressed their pleasure at seeing the actual working of the various plants and the results of the use of scientific fertilisers in active demonstration.

Weddings

The marriage of Mr. M. Damodaran, Chemical Engineer with Sri. P. Indira, took place on 27-4-48 at Chandrodayam, Kollengode.

The marriage of Mr. A. Ranganathan, Chemical Engineer with

Sow. Lekshmi, took place on 3-5-48 at Trichinopoly.

The marriage of Mr. V. G. Kamath with Sow. Prema took place on 21-4-48 at Tellicherry.

We offer our felicitations to the new couples.

Farewel

Dr. A. G. Menon, our Medical Officer, after a service in F. A. C. T. for 1½ years, has left us. He took a keen interest in sports and there was not one game in which he did not actively participate. We miss in him an allround sportsman. We wish him all success.

SAFETY

A little neglect may breed great mischief. For want of a nail, the shoe was lost; for want of a shoe, the horse was lost; and for want of the horse, the rider was lost, being overtaken and slain by the enemy; all for the want of a little care about a horse shoe nail. (Benjamin Franklin)

Little known facts about Well known persons

(1) Lenin was so much fascinated with the game of chess that he used to play the game with his friends far away by mail!

(2) Albert Einstein who is now regarded as "the outstanding intellectual giant of this generation and one of the most profound thinker of all times was once a dunce.

(3) Alexander Dumas kept several kinds of coloured paper and different sets of pen to write different types of books. But he never used blue ink!

(4) Glamorous Greta Carbo used to work in Barber's shop!

എഴുത്തുപെട്ടി.

ചോദ്യം 5.— അമോണിയം സൾഫേററ് ദ്രാവകവളമായി ഉപയോഗിക്കാമൊ? ആകാമെങ്കിൽ അതു വെള്ളത്തിൽ ലയിപ്പിക്കേണ്ട മാത്ര എന്തായിരിക്കണം?

ഉത്തരം:— ഉപയോഗിക്കാം. കമ്പോളത്തിൽ കിട്ടുന്നതിൽ നൈട്രോജൻ ഏററവും കൂടുതലായി അടങ്ങിയിട്ടുള്ള വളം അമോണിയം സൾഫേററാണ്. അതു്, ഒരു ഗ്യാലൻ വെള്ളത്തിൽ അര ഔൺസ് എന്ന കണക്കിൽ കലത്തണം. ഇതിനെ നൈട്രോജൻ ലായകം എന്നു വിളിക്കാം. ഇതു് പച്ചക്കറി കൃഷികൾക്കും, പൂന്തോട്ടങ്ങൾക്കും, പുൽത്തകിടികൾക്കും, ചീരകൃഷിക്കും മററും വളമായി ഉപയോഗിക്കാം. ഈ ദ്രാവകം ഉപയോഗിക്കുമ്പോൾ താഴെ പറയുന്ന സംഗതികൾ ശ്രദ്ധിച്ചിരിക്കേണ്ടതാണ്.

1. വളരെ ഇളയതും മൃദുവുമായ വിത്തുമുളകളിന്മേൽ ഈ ദ്രാവകം പ്രയോഗിക്കരുതു്.

2. ഉണങ്ങിയ തറയിൽ ഇതിനെ ഉപയോഗപ്പെടുത്തരുതു്.

3. തടങ്ങളെ വെള്ളംകൊണ്ടു് വൃത്തിയായി നനച്ചശേഷം വേണം ദ്രാവകം ഉപയോഗിക്കാൻ.

4. മുകളിൽ വിവരിച്ചതിൽ കൂടുതൽ ശക്തി ദ്രാവകത്തിനു പാടില്ല—മറിച്ചായാൽ ചെടികൾക്കു് ഈ വളം വലിച്ചെടുക്കുന്നതിനു കഴിവാകയില്ല.

5. വിളവെടുക്കുന്നതിനു് അല്പം മുമ്പായിരിക്കണം ഈ വളമുപയോഗിക്കേണ്ടതു്. എന്തെന്നാൽ കൃഷികളിൽ ഇതിന്റെ പ്രവർത്തനഫലം സത്വരമാകുന്നു.

6. ആവശ്യമെങ്കിൽ ആഴ്ചയിലൊരിക്കൽ ഈ വളം ഉപയോഗിക്കാം.

ചോദ്യം 6:— കറുത്ത ക്ഷാരം എന്നാൽ എന്തർത്ഥം? ഇപ്രകാരമുള്ള കറുത്ത ക്ഷാരം മണ്ണിനെ എങ്ങിനെ കൃഷിക്കുപയുക്തമാക്കാം?

ഉത്തരം:— ധാരാളം സോഡിയം കാർബണേററു് ലയിച്ചുകലന്നിട്ടുള്ള മണ്ണുകളെയാണ് കറുത്ത ക്ഷാരമണ്ണ് എന്നു പറയുന്നതു്. ക്ഷാരഭൂമിയിൽ ഉൾപ്പെട്ടിട്ടുള്ള ഉപ്പുകളിൽ എല്ലാററിലും ഉപദ്രവകരമായ ഒന്നാണിതു്. സോഡിയം കാർബണേററ് ഈറപ്പത്തിന്റെ സമ്പർക്കത്തിൽ വിഘടിച്ചു് സോഡിയം ഹൈഡ്രോക്സൈഡ് ആയിത്തീരുന്നു. ഇതു് വളരെ വീര്യമുള്ള ഒരു ക്ഷാരമാകുന്നു. ഇതു് മണ്ണിൽ കലന്നിട്ടുള്ള ജീവോല്പന്നവസ്തുക്കളെ അലിയിച്ചുചേർത്തു് ഒരു കൊഴുത്ത കറുത്ത ദ്രവത്തെ ഉല്പാദിപ്പിക്കുന്നു. തന്നിമിത്തം മണ്ണിനു് ഒരു കറുത്തനിറം ഉണ്ടായിത്തീരുന്നു. അങ്ങനെയാണു് "കറുത്ത ക്ഷാരമണ്ണ്" എന്ന പേർ ഉണ്ടായിത്തീർന്നതു്. ഇപ്രകാരം നിർജ്ജീവമാക്കപ്പെട്ട മണ്ണിനെ ജിപ്സം പ്രയോഗിച്ചും കൂടക്കൂടെ വെള്ളം കെട്ടിനിറുത്തി ഉപ്പുകൾ അലിയിപ്പിച്ചു് ചോർത്തുകളഞ്ഞും വീണ്ടും ഉയോഗയോഗ്യമാക്കാം. ധാരാളം പച്ചില വളം ഉപയോഗിക്കുന്നതും കരിമണ്ണിനെ നന്നാക്കിയെടുക്കാൻ പ്രയോജനപ്പെടുന്ന ഒരു സമ്പ്രദായമാണു്.

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FOOD MINISTER TO THE GOVERNMENT OF INDIA

AND

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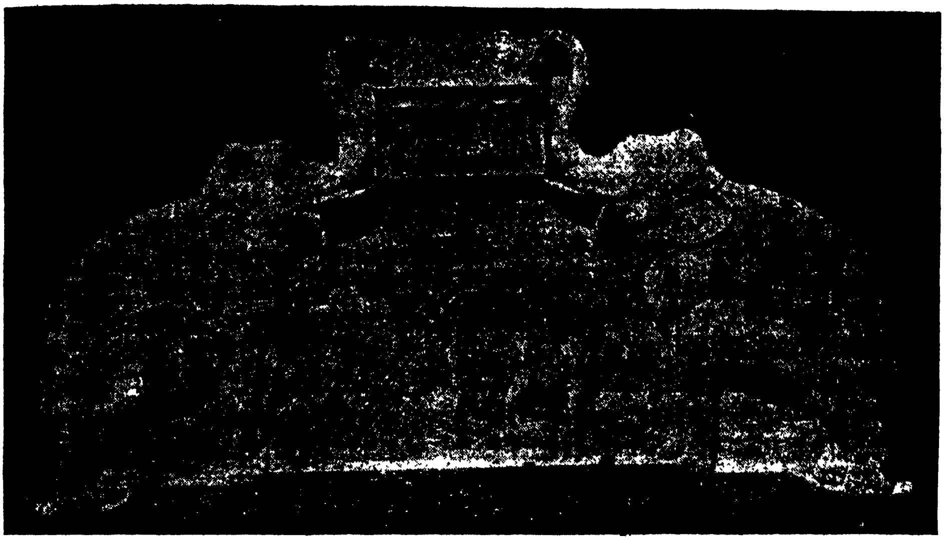

VOL. 2 | JUNE 1948 | No. 9

EDITORIAL

PRODUCE OR PERISH.

Produce or perish. That expresses precisely the dire economic position of many a country in the world today, including India.

John Bright in one of his speeches said:— "I must say that it is my belief that if a country be found possessing a most fertile soil and capable of bearing every kind of production and that, notwithstanding, the people are in a state of extreme destitution and suffering, the chances are that there is some fundamental error in the Government of that country." This is preeminently true, emphasising as it does, the paramount duty which the Government of a country owes to the citizens committed to its care, of mobilising the full food resources of the country. This should not, however, be made the excuse by the cultivator for neglecting the duty which he, in his turn, owes to the country of doing his very best to see that the lands in his possession are put to the best use and produce the best that they could, regard being had to environmental facilities. This is a matter which is partially ignored, sometimes wholly forgotten by the average man, when he talks of food production. In a recent radio talk, the Food Minister to the Government of India, made it plain that the ideal of selfsufficiency or autarky demands a close co-ordination between Governmental activities and private initiative or enterprise, if it is to become an accomplished fact.

Recent events and experiences have made it abundantly clear that the continued dependence of any country on foreign imports for its staple food products is neither feasible nor desirable. National salvation in the case of such countries therefore depends upon carefully planned action and activities on the part of both Government and the agriculturist. It is impossible in the nature of things to define precisely the duties of each, but generally speaking, it might be said, that the task of finding out facts, with a view to getting first hand knowledge of existing inadequacies; the mobilisation of all pertinent resources, the formulation of long-range policies designed to increase the extent of lands under the plough and the production from lands already under cultivation, the taking of effective steps to combat menaces to successful cultivation such as soil-erosion, the manufacture and distribution of cheap but efficient agricultural implements well within the reach of the average agriculturist should be the work of the Government. And it should be the task of the cultivator to make the best use of the facilities generously offered by the Government to improve cultivation. The traditional habit of looking to the Government, as to Providence, for every kind of help, has to be abandoned. The ryot has to realise that, unlike Providence, Government have got their own limitations.

We feel that, in these circumstances, it is the solemn duty of every cultivator in our country to respond and that immediately, to the clarion call of the Food Minister and see that all the potential resources of lands in his possession are rendered available to the nation. This means, in the concrete, that he should increasingly avail himself of the use of the moderately priced agricultural implements and tractors now in the market and acquaint himself with the benefits of manuring the lands with scientifically prepared chemicals. Worn out lands, in respect of which the law of diminishing returns is in full swing, require for their rejuvenation, something beyond nature cure. It requires, as is now well recognised by all well-informed people, a free and generous use of scientific chemical manure for them to regain their lost vigour and productive capacity, to their fullest extent.

Editorial Board.

CALL TO THE FARMERS*

THE HON'BLE SRI. JAIRAMDAS DAULATRAM.

FOOD MINISTER TO THE GOVT. OF INDIA.

I do not know how far my voice to-day through this radio talk will reach those whom I would fain address face to face, on a topic of the greatest national importance. I want to speak out my thoughts to those great builders of a prosperous India whom we know as the tillers of the soil. Scattered in lacs of villages, working on millions of fields, it is you who are creating the basic wealth of India. More than even those citizens of our country who labour over the desk or in the factories, it is you who sow and reap in numberless farms of India, who make the life of the people of this country happy and contented.

You and the rest of us have laboured and striven hard these 30 years to end India's political bondage and win for its people freedom from foreign rule. You and the rest of us have been yearning to harvest the fruits of this struggle in terms of peace, justice and prosperity for all. But this process of harvesting these fruits is proving to be tedious and tiring. It needs the co-operative effort of us all to shorten this process and bring soon within the nation's homes a sense of both freedom and happiness.

But how can such feelings fill people's hearts if, in spite of our political liberty, we are yet under foreign domination in a matter so fundamental as the economy of our national life? There can be no true political freedom unless it also spells full economic freedom. But economic freedom has no meaning, if in a matter so basic as food, our country is every year at the mercy of some international council or other, to give us rationed doles of rice and wheat and other grains for the poor man's hearth, in every one of the numberless hamlets that fill our countryside. Distant Australia, and more distant Argentina, have now to feed the villager in the remotest corner of our land.

It was with a view to end this unwholesome dependence on foreign doles that your Government felt that it was time we planned out a programme for India's freedom of food to supplement the political freedom we have just gained. A Committee on which able men worked vigorously and hard has recently reported upon the measures which must be taken to achieve this freedom of food. That report is now before us. The Committee has made valuable recommendations and Government will be coming to their conclusions in regard to these recommendations as soon as Provinces and public organisations have expressed their view on the contents of the Committe's report.

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* Reproduction of the talk broadcast from the Delhi station of All India Radio — by kind courtesy of A. I. R. Delhi.

Large multi-purpose projects, coupling irrigation with electric power, and stupendous schemes for the reclamation of waste and weeded lands have been broadly outlined by the Committee. These will no doubt cost much money and occupy several years of strenuous, efficient and co-ordinated work. This task will fall within the jurisdiction of Government. It is in this field that we must work with a far-seeing mind and a big heart and draw in and secure the co-operation of various elements of our national life, whose conjunction would lead to quickest success.

It is not the purpose of my today's talk to dilate on these projects and schemes. These must await consideration and implementation by the Government of the country in such a manner as may give us the best results. Other proposals of smaller dimensions and well within the power of Provincial Governments have also been recommended for immediate adoption. They relate to more intensive cultivation and use of improved methods on the very farms which today cannot fully feed us. It is in this sphere of action that every one of us is to be tested in the coming few years You, the tillers of the soil, have also to share in the test. And after all, what is the effort which you have to put forth?

If each cultivator put forth even one-tenth more effort than what he is giving today, the nation's immediate need would be well nigh met.

Are we so utterly helpless as to be unable to produce the eleventh stalk of wheat where today we produce only ten ?

Is it not a fact that here and there our neighbouring tillers produce twice the yield per acre which we do ? Shall we not begin to think why we should fall behind ? Your comrades of Europe are putting forth effort to increase the wheat yield by forty per cent in a single year. Your comrade in the Western countries feels that he is not working only for the needs of his family; he realises that he is producing for the needs of his country.

The same ambition should fill your heart.

Sow and reap for yourselves by all means but also sow and reap for your country.

I cannot but think at this moment of the thousands of these public servants of the Agriculture Departments of our Provinces and States, who on an occasion like this, can fittingly function as the true guides, philosophers and friends to those who produce the nation's food. These, the creators of our basic wealth, need individual help and guidance to overcome their numerous little difficulties. There could be no nobler mission for the officials of the Agriculture Department than to move in the midst of the nation's producers and help them with materials and advice so as to liberate India from its bondage for food. The role of the tiller of the soil can be as great as that of the greatest architect of India's biggest projects, and those officials of Government, who with earnestness and assiduity guide the cultivators to achieve the national goal of economic freedom, can share with them the glory of the achievement. Should we not all, non-officials and officials, feel the tragedy of the situation?

With nature's magnificent gifts of the Himalayas and the Vindhyas and their daughters, the mighty rivers, which supply the bloodstream of our economic life, with a soil which, if well tended, is suited to vast multi-purpose agricultural production, with a man and cattle power which has the potentiality, if properly used to feed half the world and feed it well and sumptuously—with all these factors in our favour—we in India seem to be destined to beg our food from half a dozen countries in the, East and West for several years to come. This is a position which no self-respecting nation can tolerate. It is a position which no self-respecting member of our nation should long tolerate.

Have we ever realised that if anything happens to interrupt the free passage of food ships across the seas, India would have to face relentless starvation?

It is a great national task which is making its call both to the tiller and to the official, and all great tasks well done cannot but evoke appreciation and recognition. Let us all fulfil our parts in the great task of making India self-sufficient in food for its rapidly growing population.

Food has always claimed first priority in our domestic life. Food has been claiming first priority in our national budget. Let food receive first priority in the nation's production plans. Agriculture is the fountain of national wealth. Food must form our principal agricultural product. We must plan for food production along more than one line.

Schemes which will take some time must be coupled with schemes which can be implemented immediately. Both need our attention. It is these latter which I am anxious today to commend both to the agriculturists and the oficials of our numerous Provinces and States. It is in this sphere that our own will and determination can largely give us the fruit. It is in this sphere that our own capacity for co-operative work can produce certain results. It would be a great pity if the qualities which carried us through to success over thirty years of political struggle, should now suddenly be unavailable when the battle for the economic freedom of India has yet to be won to supplement the achievement of political liberty.

The nation is, as I have ventured to suggest, passing through a fresh test. I hope we shall pass the test successfully. We are even now entering upon the next sowing season in the country. Our efforts during this season are to be the beginning of that test. I know that many provinces have been planning for this season. I hope full and free co-operation between the officials and the agriculturists will help the nation to achieve its first success in its march to economic freedom. Will the tiller and the public servants disappoint the nation's hopes.

WATCHWORDS OF PROGRESS: INCREASED FOOD PRODUCTION *

By

M. S. SIVARAMAN, I. C. S.,
DIRECTOR OF AGRICULTURE, MADRAS.

HOW shall we increase our food production? With war three years in retrospect, we still find ourselves in want of our basic cereal requirements, let alone protective foods such as eggs, milk, meat, vegetables and fruits. A war, an increasing population without an increasing food supply and unfavourable seasons, have all combined to produce an exceptionally acute food shortage. Attempts have been made to tackle it through various approaches; by imports, by extending cultivation to submarginal lands, by intensive cultivation of food crops and by more equitable distribution of the available supplies.

It is an irony that a tropical country like ours should have to seek food supplies from countries less favoured by nature. Imported supplies may help to tide over the present crisis, but the basic remedy lies in a re-orientation of our national, agricultural, industrial and economic policies, in improving agricultural production and simultaneously increasing the purchasing power of the masses, so that they can afford the necessary energy-giving and protective foods at a price level which foster agriculture as a competitive occupation.

Protective foods like eggs, milk and meat are luxury articles of agriculture, the production of which requires several times the area necessary for raising cereals giving the same amount of food energy. As the area of profitable cultivation in the province is limited, no general improvement in the nutritional standards can be brought about unless the yield of cultivated land is increased appreciably.

The problem of improving agricultural production is a complex matter involving not only agricultural technique but also different aspects of our social and economic life such as systems of inheritance, tenures, transport, marketing, credit etc. All the various forces that tend to adversely affect agriculture, have to be surveyed and eliminated. The farmer's problems are really the nation's problems and the state has to step in to create the necessary atmosphere for stimulating the maximum of economic production from every acre of land.

Granted all this, agricultural production itself is an uncertain element. It is a function of different variables such as manures, soils, cultural practices, seeds, water supply, climatic conditions, pests

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and diseases and other environmental factors each of which may be as important as any of the others depending on the quantity, time and duration of its incidence in the several stages of plant growth. In the present state of our knowledge, some only of these variables can be changed for the better. I shall confine myself in this talk to soil fertility and organic manures which are fundamental factors affecting food production and suggest tackling them through ways which are within the powers of every cultivator.

It must be remembered that the soil is not a static mass. It is a dynamic living organism subject to constant physical, chemical and biological changes which essentially determine its fertility. The soil is the home of myriads of micro-flora whose vital activity helps to disintegrate the remains of dead plant and animal matter into a spongy amorphous mass called humus, which again is slowly changed by other bacteria with the incidental formation of plant nutrients like ammonia and nitrates. There is a constant resurrection of dead matter which goes on continuously in the soil under favourable conditions.

The presence of humus in sufficient quantities in the soils ensures among other things the requisite conditions necessary for crop production like proper tilth, temperature and aeration. The soil retains moisture better, and there is considerable biological activity leading to a steady and balanced supply of plant nutrients. The first task of a successful farmer is therefore to keep up the life cycle in the soil and maintain and improve its humus content. Unfortunately the soil in our country is in general badly deficient in humus, as the tropical sun depletes the soil of its organic matter. The unmanured land depends on the rotting of weeds and roots of the previous crop for its humus content and this in turn leads to the formation of just enough plant nutrients to keep up a low out-turn. The chief manurial problem in India is therefore not merely the deficiency of nitrogen as observed in the Report of the Royal Commission on Agriculture. It is the deficiency of humus and nitrogen. Of these nitrogen can be synthesised but humus has to be grown.

Humus production and crop production cannot go on simultaneously in the same land in the absence of sufficient moisture and nutrients. Humus has therefore to be produced separately before applying it to fields on which rainfed crops are raised. All organic matter can be converted into humus with the help of soil bacteria by composting it in shallow pits not more than 2' in depth. For this purpose the leaves and agricultural wastes are placed in pits and moistened, with the addition of wood ash and a small quantity of cattle dung mixed with water. The contents of the pits should be turned over after 15 days and once a month thereafter. Artificial farm yard manure can thus be produced in three months time. Such careful husbanding of all organic wastes is the secret of success of the Chinese farmers who have kept up the fertility of their soils at a remarkably high level for over four thousand years.

In respect of irrigated paddy lands, the problem is simpler: for green leaves and organic matter can be applied directly to the fields. Innumerable experiments in the Agricultural Research Stations and on ryots' lands all over the Madras Province have shown that green leaves constitute the main bulky organic manure needed for paddy fields. Application of green leaves ranging from 4,000 to 6,000 pounds to an acre has increased the yields of paddy from 25 to 45%. For this purpose quick growing shrubs have to be raised all over the countryside, along the sides of roads, railways, canals and tanks, on waste lands and in all places which are not put to a more profitable use. Green manure crops like Sunhemp, Daincha, Sesbania, Speciosa etc, should be grown on paddy lands wherever possible after the harvest of the paddy crop. An acre of Sesbania Speciosa may yield as much as one lakh of pounds of green matter in five months sufficient to manure 25 acres of paddy fields. A Glyricidia stump planted on a canal or field bund will produce 40 bs. of leaves in the first year and 300 lbs. every year after three years. Unless we produce more leaves and organic matter and supply them directly to wet fields, or compost and use the artificial farm yard manure on dry fields, there can be no permanent solution of the food problem. Every ryot has therefore to take up seriously the production of more plants, shrubs, leaves and green manures in every possible area without detriment to his cultivation. Where green manures can be raised on the fields, the ryot has to learn to produce his seed requirements by setting apart, if need be, a part of the cultivated land for the purpose. If by sacrificing one cent of land to produce green manure seeds, sufficient green manure can be raised on an acre and thereby the yield of paddy can be increased by over 20%, surely this sacrifice of one cent is worth if. If by planting 15 cuttings of Glyricidia on the bunds of paddy fields, the ryot can get his manure on the spot, surely the practice should be taken up at once.

In order to intensify production every farmer has to learn to be a chemical manufacturer employing countless millions of bacteria as willing workers in his field factory.

Increased food production depends largely on increased production of manures and the possibilities are very great as nearly 80% of the cultivated lands is not manured at all. Substantial increase in the acre yields, leads to greater output of cereals. More cultivated lands can then be released for larger production of protective foods and industrial crops so essential for a balanced abundance in the country. The Madras, Department of Agriculture has started an all out drive to plant quick growing shrubs, to spread green manures and to collect and supply free to all ryots seeds and plant materials of several trees of economic importance. Once the cultivators' enthusiasm is roused and his co-operation secured, we can confidently hope for striking progress towards the solution of our food problem.

Developments in the field of Heavy Chemical Industry during 1947

By N. D. GOPINATH, B. Sc. F. I. C. S.,
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THE year '47, it may be recalled, has not been easy so far as the heavy Chemical Industries are concerned. Fuel shortage, continued struggles with Industrial labour, shortage of raw materials, mostly ferrous materials, contributed much towards the difficult progress of this Industry. But inspite of such handicaps instrument manufacturers and equipment manufacturers were loaded with orders. Several of these were for new equipment, often, the result of years of hard work and practical experience.

The outstanding achievement in the field of heavy chemical Industry was contributed by the Standard Oil Company of New Jersey. They put into practice a process for refining petroleum using a fluidised catalyst. This fluidised catalyst has the advantage that it could be removed from the reaction zone for regeneration continuously. These gas-solid-phase reactions will have much wider fields of application in the years to come. The Standard Oil Company has just set the ball rolling. Usually plants operating on this principle have reaction chambers 50 feet high & 25 feet in diameter. Each takes 300 to 400 tons of fluidised catalyst. The rate of feeding and removal of the catalysts could be anywhere in the vicinity of 50 tons per minute.

Compared with existing methods of catalyst reduction of organic sulphur in gases, the size of machinery employed to handle millions of c. ft. of gases per day, the difference in temperature of reaction and troubles in charging and recharging the catalyst, this fluidisation process might be an easy solution for such complicated chemical processes. This has been applied already to the 'Fischer-Tropsch' synthesis of manufacturing synthetic fuel. It might open out new fields in the production of Producer gas, water gas, purification of gases by the iron oxide method, catalytic exidation of NH_3 and to all processes that involve gas-solid reactions. This process is not new to the chemical field. It had been commercially employed by Fuller Kinyon pump and Winkler Gas generators. Besides its excellent temperature control, uniformity of reaction, high reaction rates, low cost of operation it has its own limitatiors. High moisture content, too high a rate of feed, adhesion or fusion of materials in the inner surface taking place, practically make this reaction dull. Ash content of fuels will adversely affect the rate of reaction. Gas solid reaction may guide the future of Heavy Chemical Industry.

Synthetic resins come next in the field of heavy chemical industry.

De-ionisation by means of cation and anion exchangers is well-known. Although the manufacture of such ion exchangers in the industrial field dates as far back as 1935, practical application of the methods in large industrial scale was materialised by the Permutit Co. of America. In the water treatment equipment manufacturing companies, the process employed is in passing water in series through cells removing cations first and then anions When the exchange capacity of the resins become low the flow of water is diverted to a fresh pair of cells and the spent resin back-flushed by water and regenerated by the addition of Sulphuric acid for cation bed and soda ash for anion bed. Sulphuric Acid and Soda Ash are the most common acid and alkali used for regeneration. The de-ionisation and regeneration processes are marked by the quite sharp changes in the pH and to the conducting values of the cell effluents The changes in pH and conductivity can by simple relays and electrode elements be made to operate motorised valves etc. This ion exchange process is being used widely in the Beet Sugar Industry in the U. S. A. The other uses are reported to be the artificial aging of whisky, recovery of acids and alkalis of metals from dilute solutions, preparation of fine chemicals, the purification and treatment of fruit juices, and acid removal from dextrose and ethylene glycol.

The ion exchange methods have their own limitations-the chief being the high cost of regenerating these resins. An application of the synthetic resins lies in the possibility of manufacture of heavy chemicals like soda ash, magnesium chloride from sea water, fluorides from fluorspar and magnesium from dolomite.

The next major development is in the filtration equipments employed in chemical and metallurgical industries—rotary, continuous pressure and vacuum filters. Considerable advances have been made in filter cloth technology. Filter cloths are available today in monel and stainless steel. Monel filter cloths had been in operation for several years and their long life under severe corrosive conditions appear to justify their initial high cost. Stainless steel cloths, from reports, are not quite satisfactory. Plastic filter cloths are available. Vinyon, Nylon and Saran have been used and are found to possess very desirable properties, corrosion resistance and long life. The optimum temperature limit for Vinyon and Nylon is 60° C. Saran cloths are reported to withstand temperature of 80° C.

The developments in the plastic industry are many but those that directly affect the heavy chemical industry are alone mentioned here. Certain plastics are sprayed to cover metals and equipments which are exposed to severe corrosive atmospheres. Plastics are also used as materials of chemical plant construction. Mention may be made of plastics like Thiokol, Polythenes, polyvinyl, acrylic and styrene. Polythenes which has a high degree of inertness is free from sulphur but has a high co-efficient of thermal expansion.

Of the millions of compounds of organic chemistry, Silicones are becoming more and more prominent. There are silicones that could be drawn into threads, made into putty, made water repellant and used as insulators. Silicone rubbers are so heat resistant that one day the motor car tyres may be made out of them. The development of silicone was stimulated by the demand for materials during war and has been rapid. Silicones have a high future in the heavy chemical industry.

Glass too is becoming a standard material of construction in the chemical industry. Resistance to corrosion, absolute cleanliness, transparency, absence of pores are marked advantages. Porcelain and vitrosils are also used largely in heavy chemical industries. Innumerable types of stainless steel have been developed on the metallurgical side.

Fertilisers are still in the high lights. Synthetic ammonia plants have been erected in India and are being erected. The main principle of Haber-Bosch flow sheets have not been materially changed in the process. The process is a monument to what chemists and engineers can do, given water, wood, (coal) and anhydrite. Spectacular changes have been made by the Travancore plant, in that it uses wood as the primary raw material. Double superphosphate has been slowly replaced by triple superphosphates. These contain 30-32% $P_2 O_5$.

Simultaneous production of sulphuric acid and Nitric acid by the K. C. P. process has been given much prominence now. This process uses towers instead of the conventional chambers thus eliminating the difficulty of recovering nitric oxide. The acid production actually takes place in the liquid phase. This process is a real alternative to the existing Chamber and Contact processes. The process is flexible and can be adapted to burner gases of varying SO_2 composition. The initial heat of burner gases can be used for concentrating the H_2SO_4 produced. Constructional charges are low.

The growth of petroleum industries is one of the startling developments in the Chemical Industry. The hydrocarbons from petroleum available for Chemical processes range from CH_4 to high molecular weight aromatics. From these, by hydrogenation, dehydro-genation, polymerisation, isomerisation, thermal and catalytic cracking, hydrocarbons of practically any structure are prepared.

Again the attention of chemists and Chemical Engineers has been drawn to the disposal of Industrial wastes Effluent problem requires so much laboratory work, engineering work and overhead expenses, that very often the executives cannot resign themselves to purchasing the plant suggested In recent years an excellent type of equipment has been developed which will remove solids, colour, odour etc The machine receives a suitably dosed effluent in the central flocculating compartment where by gentle agitation, the liquid is kept for a particular detention period and the solids removed and the settled liquor flows into other compartments.

It is not possible in this limited space to deal with all the developments in various industries like alkali industries etc. But the above few paragraphs give the outstanding inventions in the field of the Heavy Chemical Industries.

NITROGEN BALANCE (?)

BY T. S. RAMAKRISHNAN, B. Sc., Ag.,
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IF you would care to consult some standard books on general sciences, you would find many pages in them devoted to a topic, styled "Nitrogen cycle" alias "Nitrogen Balance." These books first begin talking about the importance of nitrogen for the manufacture of protein, the tissue builder. They will affirm that if there were no nitrogen available, then on protein can be produced and consequently no tissue can be built. This discussion will then conclude with the positive statement that no life—whether plant or animal is possible without nitrogen. All this is true and no student of science can afford to doubt it.

But these books do not stop with this. They proceed further and give us a very happy picture of how Nature has designed things in such a manner as to keep up a perfect balance in nitrogen supply and availability. The books do not content themselves by merely stating that a nice balance is kept up by natural agencies, but they go a still further and try to convince us by analytical reasoning. The argument runs more or less like this:—

a) The plants take up nitrogen from the soil and manufacture the vital proteins.

b) The animals (including human beings-no offence please!) derive their proteins from the plant kingdom.

c) Both the plants and animals after their inevitable death go back to the soil.

d) Their dead bodies decay by the action of bacteria and after a series of changes, more and more simplified products are produced ending with the ultimate production of nitrates, which are then taken up by the plant-roots.

e) Some kinds of bacteria in the soil have the power to fix atmospheric nitrogen and thus add to the nitrogen capital in the soils. Thus, the nitrogen goes round and round-a sort of merry-go-round, that keeps revolving the Wheel of Life.

When a student reads through these statements, he cannot be blamed if he gets the idea that everything is all right, so far as nitrogen supply is concerned; the plants and through them, the animals-have nothing to worry about at all. They will and shall get their quota of nitrogen for, you see, the nitrogen that goes out comes back to the soil by other natural ways. This is indeed a wonderfully rosy picture and we wish it were true. But our wishing won't make it appen! The facts are quite the reverse.

The beauty of the argument as put forward in these books is that

Sri V. Seshasayee reading the welcome address at the meeting held in the FACT Cafeteria Building on the occasion of the visit of the Hon'ble Sri Jairamdas Daulatram to the factory.

The Hon'ble Sri Jairamdas Daulatram addressing the meeting.

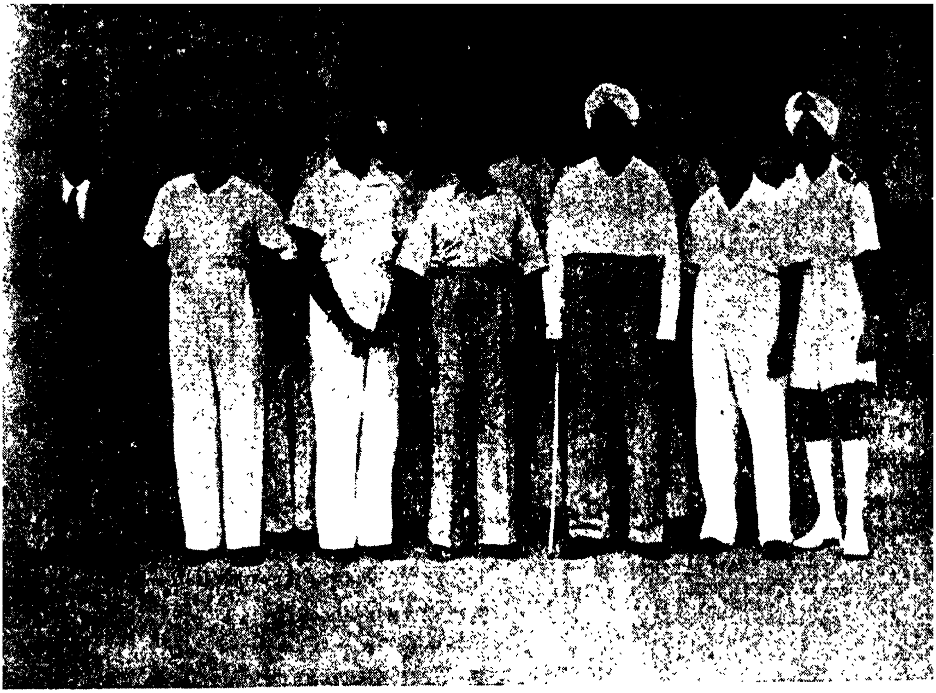
The Hon'ble Sri T. M. Verghese, Minister for Industries, Travancore, addressing the meeting.

The Hon'ble Sri Jairamdas Daulatram and party leaving FA[illegible] after the meeting

The Hon'ble Sri K. Madhava Menon, inspecting the bagging of

Farm in Veiyathunau.

Veiyathunad (in his right hand) with unfertilised paddy (in his left hand),



Group Photograph taken on the occasion of the visit of Sardar Bahadur Sir Dattarsingh, (Vice Chairman, Indian Council of Agricultural Research, New Delhi) and Party to the Factory.

FACT Experimental Garden showing the increased growth of Sugarcane due to Ammonium Sulphate.

HIS HIGHNESS THE MAHARAJA at the Nitrogen Plant.

OUR DISTINGUISHED VISITORS.....:

HIS HIGHNESS THE MAHARAJA...............in conversation.

OUR DISTINGUISHED VISITORS......

Sri V. Seshasayee, H. H. THE MAHARAJA OF TRAVANCORE, Sri Chattanatha Karayalar and the Honorable Sri Pattom Thanu Pillai.
(Sri V. Sesahasyee is seen explaining the working of the entire Ammonium Sulphate Plant with the help of a model)

every one of these steps is true by itself; but the overall picture that one gets after reading them through is totally wrong. It is true that plants get nitrogen from the soil. It is also true that animals get it from the plants and that after death and decay, both the plants and animals go back to the soil and their dead bodies decompose releasing nitrates which are taken up by the next generation of plants. But when it is said that a perfect balance is kept up by Nature in the matter of nitrogen supply, we have to disagree strongly, for, there is no such balance at all and, even if there were one it can only be a progressively losing balance, as far as the soil is concerned. If only a balance is or can be kept up, we will indeed be rid of a great deal of trouble. Everyone knows fully well that the role of nitrogen in plant or animal nutrition is so important and vital that it may be truly said "No nitrogen—no life." It must be remembered that the whole animal kingdom (including Homo Sapiens) is dependent on plants for their nitrogenous food and when the plants perish out of nitrogen starvation the animals will die out automatically, in fact, even earlier.

Let us now analyse the facts at our disposal. First of all let us look into the natural agencies through which the soil procures nitrogen. There are mainly three ways by which a cultivated soil gets its nitrogen. I advisedly write "cultivated soil" here, for, a cultivated soil is quite different from an uncultivated one. An uncultivated waste land under virgin conditions will gradually gain in its nitrogen content, if only a fair amount of precipitation is to be had. Under such forest-like conditions, nothing is taken out of the soil and dead leaves and other plant matter fall on the earth, decay and add to the organic content of the top soil and hence gradually the soil can be expected to become more and more fertile. Since the soil is completely covered by plants and trees, the force of the rains is checked and the problem of leaching and erosion is substantially lessened.

But the position is quite a different one in the case of agricultural lands. Here Man intervenes with the designs of Nature and his main job seems to be to take the maximum out of the soil in the form of food and cash crops. Man has to do this, if he is to exist on this planet and the farming carried on by him is one long fight with Nature. In such a farm soil, no balance of nitrogen can be kept up, even if the soil-bacteria are willing to work overtime. The amount of nitrogen that is lost from the soil can never be equal to that which comes in by natural agencies. If this were not so, then the question of manuring will not be so worrying a problem as it is now, but will be marvellously simplified.

Well, let us go back to the discussion of nitrogen addition to the soil. As mentioned earlier there are three methods by which this [illegible] happen. Let us take them one by one.

(1) Electrical discharges:—

Whenever there occurs a lightning discharge in the sky, as it usually happens during a storm, a little—much too little—amount of nitrogen in the atmosphere unites with the oxygen and the oxide so formed dissolves in the raindrop and falls upon the earth. It is easy enough to collect the rain and thus measure the exact amount of nitrogen so fixed and such measurements have been carried out at the famous experimental station at Rothamsted for a continuous period of 28 years. These records show an average gain of 3·91 pounds of nitrogen per acre per year. Similar measurements conducted at Ottawa for a period of 10 years place the figure at 6·58 pounds per acre per year. Of course it should be realised that this gain in nitrogen directly depends upon the number and intensity of the thunderstorms we enjoy and consequently this factor is a highly variable one. Nevertheless we will not be far wrong if we take 4 lbs. per acre as the general average. Let us be very generous and fix 5 pounds per acre per year as the average for rainfall contribution.

(2) Biological nitrogen fixation:—

A farm-soil teems with tiny—ridiculously tiny—organisms that are called bacteria. They are invisible to the human eye–but this fact does not worry them. They go about their jobs in a marvellously efficient manner and they do things, some of which are so complicated that even human beings with all their scientific knowledge and facilities cannot hope to accomplish or can accomplish only under very exacting and much too expensive conditions. There are so many bacteria in the soil that even a spoonful of earth may contain countless millions. These millions, luckily for us, are not engaged in performing one and the same function; they have different kinds among them, each carrying out its allotted duty in a silent manner. Among these there is a kind of bacteria which have the power to fix atmospheric nitrogen and manufacture complicated products which ultimately become available to the plants and through them the human beings. These bacteria are called nitrogen-fixing bacteria and there are two distinct types among these—one acting independently and the other in association with some particular types of plants.

a) The independent brand are called azotobacter—a long and imposing name indeed for such microscopic organisms! Their function is one of supreme importance to the agriculturists, but unfortunately they do not seem to be so numerous as the other kind of less important bacteria–and they function only under certain favourable conditions. They demand some warmth in the soil and if the soil is cold they stage a sit-down strike. They detest even a moderate degree of acidity and unless the acidity is neutralised by addition of chalk or lime, they will not be enthusiastic to perform their functions. Consequently, under the variable conditions that are prevalent in a soil the actual amount of nitrogen fixed by azotobacter will be relatively very limited. It is indeed a difficult and an almost impossible task to measure the quantity of nitrogen added to the soil by these bacteria. But the micro-biologists have not been unnerved by the imposing nature of this task and they have attempted to compute the exact amount of nitrogen thus fixed and from the records available to us we can safely place the figure at 25 pounds per acre per year. It should be emphasized here that we are much too generous to azotobacter when we fix the quantity of nitrogen fixed, at this level.

Symbiotic nitrogen fixation:—

b) Let us now consider the action of the other type of nitrogen-fixing-bacteria, namely, the one which acts symbiotically in co-ordination with a particular class of plants. These bacteria live within the nodules found in the roots of plants belonging to the family of Leguminosa such as sunhemp, kelinji, indigo, beans, peas, etc. They fix nitrogen from the air solely for their own growth and development. But this nitrogen becomes available to the host plants later on. Just like azotobacter, these symbiotic bacteria also abhor soil-acidity which has therefore to be corrected if we want more nitrogen to be fixed.

How much nitrogen can one expect from this bacterial endeavour? Well, here we are in a great difficulty in arriving at a general figure. Estimates differ; but from the available statistical data, the amount of nitrogen that can be fixed by raising a good crop of legume can be placed at 80 to 100 lbs. per acre—a very generous estimate. But in this case this figure is not much helpful. For, it must be noted that so much nitrogen will be added to the soil only when the whole crop is cut down and ploughed into the soil and when the decomposition proceeds in the right path and no putrefaction takes place. Unfortunately in our country the good practice of raising such green manure crops within a particular rotation scheme, has not become popular, except perhaps in a few isolated regions. Even where a legume is cultivated it is usually cut and removed to be utilised as cattle feed, in which case only a fraction of the fixed nitrogen-not retained by the animal for its growth-will return back to the soil in form of cattle manure. The preservation of yard manure is being done in a haphazard way and hence some nitrogen from the manure escapes back into the air by the action of the wrong kind of bacteria. The evil practice of using cattle dung as fuel again depletes the quantity that may actually go back to the soil.

Hence the nitrogen addition by this kind of bacteria depends upon whether a legume is cultivated deliberately for the purpose of being ploughed in and so any generalisation in this case is made very difficult, in as much as the area under legumes in a year is very limited.

Nevertheless, let us once again be generous and assume that a legume is cultivated in all our lands once in every three year-rotation (as in the case of black soil-rotation—cholam, cotton, legume) and that the legume is totally returned to the soil (which is far from true). Then we arrive at the figure of about 30 lbs. of nitrogen per acre per year.

Till now we have been looking into the question of nitrogen addition; now let us take up the other side-the black side-and find out how nitrogen is being lost by the soil.

(I) Loss by erosion and leaching:—

Erosion is a deadly enemy and is the worst of all curses to mankind. Erosion refers to the washing away of the rich friable top-soil by heavy rains and leaching to the loss of soluble plant foods from the soil. The human race depends for its food on the productive capacity of this thin layer of earth's crust. Whenever there is a heavy shower, the waters beat upon the topsoil, dissolve whatever nitrogen there may be in the soluble form, and carry it away along with the minute fractions of the soil particles, which alone can give some sort of retentive power. The leaching loss alone—either by surface washing or by deep percolation—can be very great; but when this is accompanied by erosion, then the loss will become tremendous.

Nitrogen in the ammonia or nitrate form is in a soluble state and hence liable to be washed out by rains. Of these two forms the former, namely, the ammoniacal form has some close friends (colloids) in the soil-body, which retain it in them and are not willing to part with it easily. But the nitrate has few companions to attach itself to and as such is the most liable to be leached out. It may not be fully realised how serious a problem leaching is. Just to illustrate, I would like to describe an interesting and instructive experiment carried out at Rothamsted.

This particular experiment was conducted to study and compute the nitrogen—removal from an ordinary farmland. The plot selected received farm yard manure, supplying 201 pounds of nitrogen per year. Every year a wheat crop was raised and the experiment was conducted continuously from 1865 to 1914-a pretty long period indeed, long enough to do away with the play of the chance factor. Every year the land received 201 pounds of nitrogen from manure and another 7 lbs. contributed jointly by the rainfall and the seed sown — 208 lbs. in all. In 1865 when the trial was started the nitrogen capital in the soil (up to a depth of 9") was found to be 4850 lbs. In 1914 the figure was 5590 lbs. - a gain of 740 lbs. in 49 years. This works out to nearly 15 lbs. of nitrogen per year. Each year the wheat crop removed about 50 lbs. of nitrogen. Theoretically speaking there should be a gain of 208-50 = 158 lbs. per year. Hence the loss of nitrogen by leaching amounts to 158-15 = 143 lbs. per year–a colossal loss! Even allowing for the contribution by azotobacter (25 lbs.) the loss works out to 118 pounds per year.

This experiment brings home to us the enormity of the loss that a farmland is subject to. This loss will be much more severe if the land is very slopy and subject to severe gully erosion.

This experiment incidentally explodes the common belief that nitrogen as applied in the form of yard manure is the least liable to be washed out, since the nitrogen in this case is locked up in an insoluble form as complex proteins. The plot under trial received only yard manure and yet the nitrogen removal has been enormous.

(2) Crop removal:—

Man grows crops for his food purposes, for a purely selfish purpose and when he harvests the crops, he is taking away from the land a large quantity of nitrogen. All crops do not take the same quantity of nitrogen. Their nitrogen-needs are variable; for example, paddy crop takes nearly 48 lbs, plantain 200 lbs., tobacco 67 lbs., potato 47 lbs., cotton 97 lbs. and so on from an acre of soil. When the crops are raised year after yearand harvests made, the loss being continuous, drains away the fertility. We cannot possibly take an average figure for crop removal but yet one will admit, we will not be far wrong when we put 40 lbs. of nitrogen per acre per year for Crop removal. We are much too conservative. It must be remembered that many of our lands are double and triple croplands.

A question may be asked—what about the nitrogen that is already existing in our soils? Well, here again, we are forced to draw a very gloomy picture. Most of our soils are highly deficient in their nitrogen-content, as is borne out by the various soil surveys conducted by the different governments so far. The soil nitrogen is locked up in the organic matter in the most complicated way. In its present state it is inactive or non-available. It has to be worried out step by step by a mighty bacterial effort. These particular bacteria which simplify the organic content of the soil demand some optimum conditions for efficient work such as sufficient warmth, moisture, good aeration and absence of acidity, that is to say, an adequate availability of exchangeable calcium. If these factors are present, then the tiny organisms work hard. But the conditions within the soil-body are so variable, that no one can expect that ideal conditions will prevail continuously. When there is a disturbance in these conditions, as it often happens, then another brand of bacteria come into the picture and these are harmful ones called the putrefactive bacteria. These have the power to extract the oxygen from the nitrates themselves setting free nitrogen, which readily escapes into the air. This is pure loss.

Hence it can be realised that, though there can't possibly be any gain in the course of breaking down of organic matter, (for in this case only the nitrogen already present in the soil is being acted upon) there can however, be a great amount of loss.

Let us now sum up and try to strike up a balance sheet for soil-nitrogen:—

Gains:—

1) A gain of 5 pounds of nitrogen from storms.
2) A gain of 25 lbs by the effort of azotobacter
3) A variable gain of 30 lbs. from leguminous crops.

Total = 60 lbs

Losses:—

1) Loss of not less than 100 lbs. by leaching and erosion – (figure has been further reduced)
2) Loss of 40 lbs. by crop removal.
3) The possibility of soil nitrogen escaping into the air by the action of the wrong kind of bacteria. (No figure has been fixed for this loss.)

Total = 158 lbs.

Deficit = 98 lbs per year per acre.

This is a balance sheet with a minus balance and there can't possibly be an equilibrium, however much the natural agencies work hard.

We have to wipe off this deficit somehow if the fertility of our lands has to be maintained at a safe level. How are we to do it ? Can we do it solely by dumping organic manures—either plant or animal ? Or have we to tap other sources for nitrogen ? The problem of nitrogen supply is of such magnitude that we can't possibly solve it by merely utilising the organic wastes alone. For if you think and worry out the problem for a few minutes, you will realise that much more nitrogen from the soil goes back to the air than that which comes back. Just to emphasize this important fact I would like to remind you of the following truths:– (a) Plants cannot take nitrogen directly from the air. (b) Soil nitrogen is being lost by the action of putrefactive bacteria. (c) Whenever organic matter is burnt nitrogen goes back to the air. (d) The leaching loss and erosion losses are so great that they can't be compensated by azotobacter or rainfall or the symbiotic kind of bacteria, even if all of them put forward their maximum effort. (e) Organic matter is nothing but another form of nitrogen taken from another soil and hence by dumping them in our soil we are in a way transferring the nitrogen from one place to another; meanwhile tons of nitrogen are being washed out from the earth's crust and go to the oceans, from where it is impossible to salvage them. (f) Rains, though very welcome, are only mixed blessings as they rob the nitrates from our lands. Sir Napier Shaw calculates that in the Eastern countries in England 2'2 bushels of wheat are lost for each inch of autumn rainfall.

All these facts will, I am assured, have brought home the one important fact that there can only be a losing equilibrium in the soil, so far as nitrogen is concerned. The truth of this can be understood more fully if you view the whole question on a national scale, nay, on a global scale. Then, what is the solution? Well, why not we just trap the nitrogen from the atmosphere itself, which, as you know contains 78% of it? This is indeed a promising step—a step which will rid the world of its worry, a step which will permit the land to support a much larger population. The magnitude of this source can be better realised when you go through the following facts. The quantity of nitrogen in the air over every square mile of the earth amounts to 20,000,000 tons and this alone at the present rate of consumption will be enough to supply the whole globe for 14 years. The earth's surface is some 200,000,000 sq. miles. Just compare this with the negligent amounts which the natural agencies-rainfall, azotobacter etc. contribute. This source is indeed inexhaustible Those who relish to talk much about Nature and a lot against chemical fertilisers, must remember that we are after all fixing nitrogen, that has escaped from the soils, manures, etc. by "natural" agencies and that too not in an inactive form, but in a readily available state. The limitless ocean of nitrogen in the air is just around the corner waiting and demanding to be exploited. Scientists are now fixing and taming it in ever increasing quantities and in doing this they are only adding to the productive power of our soils.

Commercial nitrogen-fixation may be said to have commenced in the year 1903 when the first sucessful experiments were carried in Norway by Birkeland and Eyde, with the arc process. This was then followed by the cynamide process and later on by the synthetic-ammonia process. From the ammonia thus produced ammonium sulphate is manufactured in which form the nitrogen (that elusive, invisible, Scarlet Pimpernel of Nature) is present in a soluble, active form and can go directly to feed the plants, and through them the human beings. Thus in an age of increasing population and dwindling soil fertility, the only practical solution will be the fixation of more and still more nitrogen from the air. As our knowledge of Nature increases we are able to tap more and more of her limitless resources.

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Question Box

(In this Section answers are given by our Agricultural Chemist to questions received from the public on Soil, Agriculture and use of Fertilisers.)

Question No. 17.

We cultivate jowar (cholam), cotton and wheat in our black soils, and groundnut followed by jowar and tur-dhal in our Karif soils that are not so fertile as black soils. How am I to apply fertilisers to these two kinds of rotations? (Region-Bijapur District.)

Answer:- (a) For black soils:-

Dose: Ammonium sulphate-
2 cwts per acre.
Superphosphate
1 cwt. "

The two fertilisers have to be mixed thoroughly and applied to the cereal crop, i.e., either jowar or wheat. Such an application will benefit not only the shallow-rooted cereal but also the deep-rooted cotton crop that follows the cereal. Thus the dose recommended above is a combined dose for the two crops of jowar and cotton or wheat and cotton. The actual application can be in either of the two following methods, namely, (a) prior to the sowing, that is, during the ploughing operations which are generally started as soon as the monsoon commences or (b) as a top-dressing about 35 days after the sowing—to the standing crop. The first method is to be preferred, for, in this case the fertilisers are well worked into the topsoil during the ploughings This deep working is particularly essential for the efficient action of superphosphate. The second method of applying the fertilisers to the standing crop may be adopted only if you have some irrigational facilities or if you have some good rains during and after the application of fertilisers, as it is important to wet the soil after ammonium sulphate is broadcast. It is always expedient to apply the fertilisers only on wet soils. Since your region has very low precipitation, the question of wetting the soil assumes importance.

(b) For Karif (ordinary) soils:-

Dose: Ammonium sulphate-
1 cwt. per acre.
Superphosphate
1 " "

The two should be intimately mixed together and applied as a basal dressing to the jowar or to groundnut crop, before sowing. The superphosphate, especially, will increase the yield of groundnut substantially. The method of topdressing to the standing crop should not be adopted to these soils, whose moisture retentive power is very low. The fertilisers should be applied and worked into the top layer during the ploughing operations carried out prior to the sowing.

Question No 18.

How does magnesium benefit crop growth?

Answer:—

Magnesium is one of the most indispensable plant nutrients. It directly encourages root-development and it also helps in the movement of phosphorous within the plant-body. Magnesium also takes an active part in the production of fats and that is why it is considered so important in the formation of healthy, well-filled seeds. But most important of all, magnesium is indispensable for the formation of chlorophyll, that wonder green pigment of all plant life. Lack of magnesium immediately puts an end to the production of chlorophyll and consequently produces a severe form of chlorosis—or the yellowing of the leaves. At first the leaves become mottled, curl upwards and finally they turn yellow all over. Consequently the plant will be stunted in growth and stature, the stems remaining extremely thin and slender and the roots devoid of adequate number of lateral rootlets. The plants become very susceptible to the attacks of insects and fungi. Magnesium, when found lacking, can be easily supplied in the form of magnesium sulphate (Epsom salt). A few pounds of this salt will suffice for an acre of soil. The salt can best be applied as mixed with fertilisers.

Question No. 19.

Which is the best method for applying your fertilisers to tapioca?

Answer:-

There are two distinct methods of planting tapioca, namely, pit planting and ridge-planting.

(a) For pit planted tapioca the fertiliser mixture (ammonium sulphate and superphosphate) should be applied about 2 to 3 months after the planting of tapioca setts. You must apply the fertiliser mixture only during the rainy months and not on dry soil. Fertilisation can thus easily be done during the earthing up operations that are generally carried out for tapioca. The mixture can be applied around the base of the plant and a little away from it and then covered up by the soil so as to form a mound around the plant, which directly helps to give big sized tubers. The dose should not be less than at least 2 ozs. of fertiliser mixture per plant.

(b) For ridge-planted tapioca a different method may be adopted The fertiliser mixture can be applied early during the formation of ridges. The mixture should first be broadcast thinly over the spot where the ridge is going to be built. Generally green leaves are heaped up over these spots and then the earth on either side is dug and heaped over these green leaves. The fertiliser mixture should be scattered over these green leaves and then the ridge formed. This will be ideal, for, the fertilisers, especially ammonium sulphate, supplies free nitrogen for the bacterial action and consequently the green leaves will decompose quickly and form humus, which in its turn absorb all the plant nutrients in the fertilisers in itself and supply them later on gradually to the roots when they penetrate down in search of food.

Tapioca though an important staple food crop of the State is totally neglected so far as manuring is concerned. In this connection it may be pointed out that in our Experimental Garden we have grown tapioca of giant stature (12 feet in height) giving an yield of nearly a maund of large sized tubers. This has been made possible mainly by the judicious use of fertilisers.

NEWS & NOTES..........in brief

Food Minister's assurance to Travancore.

The Hon'ble Mr. Jairamdas Daulatram, Food Minister to the Government of India during his recent visit to Trivandrum expressed his determination to deal adequately with the food situation in the deficit areas in the country, particularly the southern portions of the peninsula. In the course of an interview he is reported to have said "I expect to pay another visit to the South in July or August and if necessary I will visit the South again in October. The food situation in the South is not a problem for Madras and the neighbouring States alone. It is as much our problem and we shall tackle it as best as we can."

Delhi food Conference.

During the Food Conference recently held at Delhi, the Hon'ble Sri Pattom A. Thanu Pillay, Prime Minister of Travancore pressed the case of Travancore for an adequate supply of rice at fair price. Given below are some relevant extracts from his speech indicating the present food situation in Travancore

"Travancore stands on practically a different footing from any other part of India except Cochin. We heard a good deal about the difficulties of other Provinces and States; but the position of Travancore-as also that of Cochin-is far more difficult. Even before the war we were importing about 60 per cent of our requirements from outside. Our staple food is rice and the Travancorean finds it hard to consume anything other than rice as his staple food. After the war started, the same condition of things continued. No doubt the Government of India came to our rescue. While our requirements from outside stand at about 4 lakhs tons of rice annually, which is calculated on 12 oz. ration basis, this year we have been allotted 2,60,000 tons on an 8 oz. ration basis. No where in India is a man compelled to be satisfied with anything less than 8 oz. a day. Now, Sir, the object of introducing control and making arrangements for the supply of food grains is to see that the prices are kept at a reasonable level, and that the poor man gets the necessary food. In respect of both these aspects of the question, I have to tell this House our difficulties in Travancore. In the beginning of the current year, we had very little stock. The result was that we had to reduce our rice ration to 4·75 oz. and the rest had to be made up by millets and other things which the Travancorean does not relish. Not only that, we could not, in fact, give them even this 8 oz. regularly. Though nominally the ration was at 8 oz. we had to give far lower ration and the actual quantity distributed was very much less. That was because of our difficulty in getting adequate stocks in time. Therefore, as far as Travancore is concerned, adequate stocks should be made available from time to time.

In respect of stocks at present with reference to the allotments that have been made, our position is fairly satisfactory. But the allotment is by no means adequate. We require at least 40,000 tons more by the end of this year to meet our requirements on the 8 oz. basis. That is one aspect of the matter.

Price Position.

With regard to price, Travancore is really in a very difficult position. My friend Mr. Reddy referred to the subsidy from the centre, and I want the House to bear with me for a few minutes when I dwell upon the way Travancore has been hit by these transactions. The price we pay for our rice is Rs. 22/11 per maund. Much was heard about the price in Bombay as a result of decontrol being as much as Rs. 22/- or about that, per maund and that it was an extraordinary situation. But this is exactly the rate at which we have been supplied rice by the Government of India. I may tell you that practically all our rice is supplied to us from imports from overseas. Under very special circumstances a quantity of about 7,000 tons was given to us from Orissa recently. But all the rice supplied to us has been coming from overseas and the price fixed is Rs. 22/11. How does this work out ? That is the point that I want this House and you sir, particularly to consider. I request the Government of India to consider it in detail and see what relief they can give us. The selling price in Madras and I may refer to Malabar in particular where the conditions are very similar to those in Travancore and Cochin is Rs. 129 per/maund while we in Travancore buy it at Rs. 22/11 and sell at Rs. 15/11. That costs the Government of Travancore a good deal. We have been losing very heavily. I may tell you that in respect of these food transactions up to the 1st January 1948, we incurred a total loss of Rs. 156 lakhs. That was before the enhanced prices were fixed by the Government of India in the beginning of 1948. But even before that the provinces were being subsidised by the Government of India, but we got nothing. From the beginning of 1948, the price has been fixed at Rs. 22/11. If we continue to sell at Rs. 15/11, our total loss would be about Rs 4·2 crores, for one year. If we go to the prevailing price in Madras our loss would be 6 crores. But our total revenue is only Rs. 8 crores. How can the State meet this loss? The Government of India may say to me "It is your look out. We can only supply you the food and it is for you to meet the loss." But let me request the Government of India to consider one thing. Any way Travancore is part of India as much as Madras or Bombay. No doubt for historical and other reasons, conditions may be a bit different The relations subsisting between the Government of India and Travancore on the one hand and that between the Government of India and Bombay or Madras on the other may not be identical. But are the Government of India going to rely on that and tell us, "You should shift for yourselves." Sir, you began your speech by saying that our business must be to see that every Indian gets enough to eat and that at reasonable prices. I ask the Government of India whether their present attitude to our State is a right one..."

FACTS THAT INTEREST

Continuous Process for Triple Superphosphate.

A continuous process for the manufacture of triple superphosphate has been developed at the fertiliser works of the Tennessee Valley Authority (Ind. Eng. Chem. 1947, 39, 1265). The chief advantages of the continuous process over the older batch-mixing process are less labour, power, maintenance requirements, better mixing and conversion of P_2O_5, lower investment, almost automatic control and more flexible operating control.

When rock phosphate and phosphoric acid are mixed, the mixture is first quite fluid, in the second stage it is plastic and difficult to mix, and finally it becomes relatively dry and easy to break up. The fluid stage can be prolonged by intensive mixing, and laboratory studies have shown that a continuous process in which mixing was completed before the slurry began to solidify would offer a number of advantages. Preliminary tests with mechanical mixing were unsuccessful but encouraging results were obtained with a mixer consisting of a funnel-shaped bowl, into which acid was introduced tangentially and pulverized rock was injected at sufficient velocity to throw it into the centre of the bowl Mixing by turbulence occurred chiefly in the discharge extension of the bowl, and to a lesser extent on the receiving belt.

Laboratory experiments have shown that acidulation had relatively minor effect on fluid time, but that an increase of 4 per cent in the P_2O_5 content of the rock caused a four-fold increase in setting time. Increasing the percentage of -325 mesh particles caused a sharp drop in fluid time. This period was also reduced with increase in acid temperature, while as regards acid concentration, minimum fluid times occurred with 75 and 79 per cent H_3PO_4 for Tennessee rocks containing 32·7 and 33·4 per cent P_2O_5 respectively. In a plant-scale unit, 82 per cent phosphoric acid, first diluted to 74 to 78 per cent, flows by gravity through a Fischer-Porter rotamatic acid flow controller-recorder to acid distributing nozzles in the mixer. American Iron and Steel Institute, (type 316,) stainless steel is used for parts in contact with acid. Large particles, sometimes found in the acid, are prevented from reaching the controller by a stainless steel strainer. Compressed air used for the controller, which operates a valve in the acid feed line, is dried by alumina gel. Rock phosphate ground to contain 75-80 per cent of -200 mesh, is delivered from a bin to a constant weight feeder through a 9" variable speed screw conveyor; the conveyor speed is controlled by conveyor mechanism. The rock, after discharge from the feeder, is transferred by a 6" screw conveyor to a vertical spout over the centre of the mixing bowl. In order to prevent surges in delivery the rock level in the feeder is maintained automatically.

Acid is introduced into the mixer, an inverted truncated cone with a cylindrical extension, through four 1" pipes with nozzles turned flat against the mixer wall; a swirling motion is thus imparted to the acid. Rock falls into the vortex formed by the tangential introduction of the acid, the fluid level is being held slightly above the mixer dicharge extension. Under normal operating conditions, 30 tons of superphosphate per hour, retention time in the mixer is about 2 secs. with 2'5" dia. discharge extension The mixing unit can be operated by 2 men and causes no trouble with careful control of the acid and rock feeds.

A horizontal rubber belt conveyor receives the discharge from the mixer. The product is cut by knives as it is conveyed towards a squirrel cage rotary disintegrator, located above the head pulley of the belt. Material is retained on the belt for about 1'25 min.; this retention period is important, since it must be long enough to permit adequate drying and hardening. Fresh superphosphate as discharged is relatively dry and is more easily disintegrated than the batch-mixed product.

Electric Treatment for Plant Diseases.

One important result of the experiments in Britain enlisting electricity to gardening work is the possibility now established of influencing the nature of the soil electrically. A form of electrical 'immersion' or impulses generated through electrodes, has been found to destroy soil bacteria. Machines have been designed which can be used to sterilise the soil. Plants and roots can also be similarly sterilised It is even hoped that further experiments in progress may lead to new ways of combating plant diseases, which will revolutionise agricultural prospects all over the world.

The pioneers in this field of experiments are two British engineers, Mr. Cameron Brown and Mr. Golding.

Active Carbon For Industries.

Increased use of Coconut Shell.

The coconut industry in Travancore is to have a new impetus with the marketing possibilities of active Carbon-a direct product obtained by the destructive distillation of coconut shells, and largely used in refining industries, such as vegetable oil, glycerine, sugar and water purification and in pharmaceutical and beverage industries.

At present the requirements of this material in India are obtained mainly by imports.

Acetic acid and acetone, two of the valuable by-products obtained from the volatile gas formed during the distillation of shell, are in great demand in consuming industries and will be additional encouragement for the coconut shell industry. Besides these, methanol and phenol are also obtained in the process.

FACT NEWS

SPORTS

Football—Inter-Division Tournament.

In the replay of the finals in the Inter-Division Football tournament, Chemical Control beat Engineering by 2 goals to one.

Though each team pressed hard, no goal was scored during the first half-time. On changing ends Vasudevan Nair of Chemical Control in a solo effort reached the goal area with the ball and scored the first goal by converting a penalty awarded in his favour. A short while after, he scored the second goal for the Chemical Control. P. N Menon for the Engineering reduced the margin by scoring a goal but thereafter the result was never in doubt and the final whistle saw the Chemical Control emerging victorious.

Panicker, Gopinath and David played well for the winners. Chemical Control which is the heart and nerve centre of the process carried on in every section of the plant proved to occupy the same position in the foot-ball field as well. Our congratulations to the members of the winning team.

Members of the winning team:

Cherian A. M. David M. A.
Gopalakrishnan. Gopinath A.
Kesava Pillai. Panicker K. B.
Pillai P. K. G. Vasudevan Nair.
Ranganathan N. R.

Badminton Tournament.

The semifinals between Madhavan Nair and partner on the one hand and Balakrishna Pillai and partner on the other proved to be the most exciting of the matches in the tournament. The play on the first day had to be postponed due to light failure. On replay though Balakrishna Pillai and partner were beaten, they fully extended the winners During the deciding third game, Kamath (Balakrishna Pillay's partner) who was playing exceedingly well, unfortunately strained a muscle and was disabled from playing his usual game thereafter—and Madhavan Nair and partner annexed the game and match.

In the finals, Madhavan Nair and his partner Anantaram by beating K. R. G. Nair and partner in two straight games came out as winners. Our congratulations to the winners.

Prize Distribution.

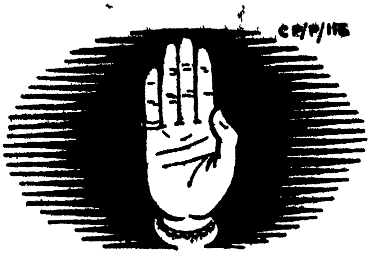
The prize distribution to the winners of the events in the Inter-Division tournaments came off on the 7th of June. Mr. K. Sreenivasan of the Managing Agents presided. Mrs. Varma distributed the prizes. Mr. V. Seshasayee's Rolling Trophy for the winners in the Interdivision football tournament was received by Mr. Powell, as nonplaying captain of the Chemical Control team. The Rolling Trophy donated by Mr. Van Ness for the winners in Volleyball, was received by Mr. Paul Pothen as non-playing captain of the Engineering team. Individual prizes were distributed to the members of the winning teams.

WEDDINGS

The marriage of Mr. M. C. Verghese, Acting Superintendent, Ammonia Division with Miss Chinnamma Jacob, formerly Chemist in Laboratory, took place on 3-6-1948 at the St. Thomas' Anglican Church, Thalavady.

The marriage of Mr. R. Krishnan, B. Sc. (Publicity Department) with Sow. Rajalakshmi, took place on 3-6-1948 at Ravanasamudram, Tinnevelly District.

We offer our felicitations to the new couples.



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